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IAA (A-10000 Series) A79-16981 A79-20476

AERONAUTICAL ENGINEERING

A Continuing Bibliography

Supplement 108

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in March 1979 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA)*



Scientific and Technical Information Branch

1979

National Aeronautics and Space Administration

Washington, DC

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INTRODUCTION

Under the terms of an interagency agreement with the Federal Aviation Administration this publication has been prepared by the National Aeronautics and Space Administration for the joint use of both agencies and the scientific and technical community concerned with the field of aeronautical engineering. The first issue of this bibliography was published in September 1970 and the first supplement in January 1971. Since that time, monthly supplements have been issued.

This supplement to *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 517 reports, journal articles, and other documents originally announced in March 1979 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*.

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged in two major sections, *IAA Entries* and *STAR Entries*, in that order. The citations, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* and *STAR*, including the original accession numbers from the respective announcement journals. This procedure, which saves time and money, accounts for the slight variation in citation appearances.

Three indexes -- subject, personal author, and contract number -- are included.

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TYPICAL CITATION AND ABSTRACT FROM STAR

NASA SPONSORED DOCUMENT		AVAILABLE ON MICROFICHE
NASA ACCESSION NUMBER	N79-10024*# Northrop Corp Hawthorne Calif Aircraft Group	CORPORATE SOURCE
TITLE	STUDY OF AERODYNAMIC TECHNOLOGY FOR VSTOL FIGHTER/ATTACK AIRCRAFT HORIZONTAL ATTITUDE CONCEPT Final Report	PUBLICATION DATE
AUTHOR	S H Brown May 1978 242 p refs Sponsored in part by the David Taylor Naval Ship Research and Development Center Bethesda Md (Contract NAS2-9771)	AVAILABILITY SOURCE
CONTRACT OR GRANT	(NASA CR-152130 NOR78-54) Avail NTIS HC A11/MF A01 CSCL 01A	COSATI CODE
REPORT NUMBERS	<p>A horizontal attitude VSTOL (HAVSTOL) supersonic fighter attack aircraft powered by RALS turbopan propulsion system is analyzed Reaction control for subaerodynamic flight is obtained in pitch and yaw from the RALS and roll from wingtip jets powered by bleed air from the RALS duct Emphasis is placed on the development of aerodynamic characteristics and the identification of aerodynamic uncertainties A wind tunnel program is shown to resolve some of the uncertainties Aerodynamic data developed are static characteristics about all axes control effectiveness drag propulsion induced effects and reaction control characteristics</p> <p>G Y</p>	

TYPICAL CITATION AND ABSTRACT FROM IAA

NASA SPONSORED		AVAILABLE ON MICROFICHE
AIAA ACCESSION NUMBER	A79-10266*#	AUTHORS
TITLE	An experimental study of three-dimensional turbulent boundary layer and turbulence characteristics inside a turbomachinery rotor passage A K Anand and B Lakshminarayana (Pennsylvania State University, University Park, Pa.)	AUTHOR'S AFFILIATION
TITLE OF PERIODICAL	(American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, London, England, Apr 9-13, 1978, Paper 78-GT-114) ASME, Transactions, Journal of Engineering for Power, vol 100 Oct 1978, p 676-687, Discussion, p 688-690 19 refs Grant No NGL-39 009 007	PUBLICATION DATE
	<p>Three dimensional boundary layer and turbulence measurements of flow inside a rotating helical channel of a turbomachinery rotor are described The rotor is a four bladed axial flow inducer operated at large axial pressure gradient The mean velocity profiles, turbulence intensities and shear stresses, and limiting stream-line angles are measured at various radial and chordwise locations, using rotating triaxial hot wire and conventional probes The radial flows in the rotor channel are found to be higher compared to those at zero or small axial pressure gradient The radial component of turbulence intensity is found to be higher than the streamwise component due to the effect of rotation Flow near the annulus wall is found to be highly complex due to the interaction of the blade boundary layers and the annulus wall resulting in an appreciable radial inward flow, and a large defect in the mainstream velocity Increased level of turbulence intensity and shear stresses near the midpassage are also observed near this radial location</p> <p>(Author)</p>	

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 108)

APRIL 1979

IAA ENTRIES

A79-17018 Fibre-composite reinforcement of cracked aircraft structures - Thermal-stress and thermal-fatigue studies A A Baker, G A Hawkes, and E J Lumley (Department of Defence, Aeronautical Research Laboratories, Canberra, Australia) In ICCM/2, Proceedings of the Second International Conference on Composite Materials, Toronto, Canada, April 16-20, 1978
Warrendale, Pa, Metallurgical Society of AIME, 1978, p 649-668 5 refs

Boron fibre reinforced plastics have been used successfully at ARL, Australia, to repair fatigue or stress-corrosion cracked metallic aerospace components. However, problems in the use of this repair technique can occur, in certain circumstances, due to the tensile residual stresses which arise in the metal component, caused by the mismatch in thermal expansion coefficients between the fibre composite and the metal. This paper describes (1) studies using X-ray diffraction procedures, to determine the stress distributions in cracked and uncracked reinforced 7075T6 aluminium specimens (carbon-fibre reinforced plastics were used as the reinforcement to allow X-ray penetration to the metal surface), and (2) experiments to establish the resistance of the epoxy-nitrile adhesive layer to damage, in boron fibre reinforced aluminium alloy specimens, when subjected to thermal cycling (Author)

A79-17029 * Predicted inlet gas temperatures for tungsten fiber reinforced superalloy turbine blades E A Winsa, L J Westfall, and D W Petrusek (NASA, Lewis Research Center, Cleveland, Ohio) In ICCM/2, Proceedings of the Second International Conference on Composite Materials, Toronto, Canada, April 16-20, 1978
Warrendale, Pa, Metallurgical Society of AIME, 1978, p 840-857 23 refs

A procedure is presented for predicting the magnitude of the turbine inlet gas temperatures potentially achievable using first generation tungsten fiber reinforced superalloys (TFRS) turbine blades. Both uncoated blades and blades with thermal barrier coatings are considered. The thermal conductivities of two representative TFRS were measured over a range of temperatures. The results show that cooled TFRS blades may allow significantly higher gas temperatures than are possible with superalloy blades. For one design, the difference is about 150-200 K (M L)

A79-17058 Gearbox casings of fibre-reinforced plastic for aero engines A Rossmann, W Feist, and H Zech (Motoren- und Turbinen Union GmbH, Munich, West Germany) In ICCM/2, Proceedings of the Second International Conference on Composite Materials, Toronto, Canada, April 16-20, 1978
Warrendale, Pa, Metallurgical Society of AIME, 1978, p 1408-1423

The development of a technique for manufacturing aircraft turbine engine gearbox casings out of carbon-fiber reinforced epoxy resins is described. The GE J-79 11A engine external gearbox was

selected as a model for development work. Because of the complicated shape of the casing, a nondirectional fiber compression molded material was chosen. The strength properties of this material were at least equal to those of the Mg casting. Advantages are (1) freedom from corrosion, (2) good vibration characteristics, (3) 30% weight saving, (4) inexpensive manufacturing process, and (5) relatively low thermal expansion. Testing of the casing concentrated on the characteristics of the fastening of antifriction bearings and gaskets, screwing together and sealing of the casing halves, and fastening of accessories P T H

A79-17059 The design and fabrication of the de Havilland DHC-7 nose avionics compartment using aramid composites L K John (de Havilland Aircraft of Canada, Ltd, Downsview, Ontario, Canada) and L L Bryson (Boeing of Canada, Ltd, Winnipeg, Manitoba, Canada) In ICCM/2, Proceedings of the Second International Conference on Composite Materials, Toronto, Canada, April 16-20, 1978
Warrendale, Pa, Metallurgical Society of AIME, 1978, p 1424-1441 Research supported by de Havilland Aircraft of Canada and Boeing of Canada

Several features of the design, testing, and manufacture of the DHC-7 nose cone, which is made of aramid composites, are discussed. Development of the structural configuration is surveyed, and design details such as shell structure and shelf support are examined. Fabrication of components of the avionics compartment is described, and lightning protection is considered. Testing verified the suitability of the material and the design (M L)

A79-17066 Defects experienced in the production of advanced composite outer wings for the A-7D attack aircraft J H Pimm (Vought Corp, Dallas, Tex) In ICCM/2, Proceedings of the Second International Conference on Composite Materials, Toronto, Canada, April 16-20, 1978
Warrendale, Pa, Metallurgical Society of AIME, 1978, p 1621-1635 5 refs Contract No F33615-73-C-5066

The primary structural box of the outer wing was constructed of hybrid boron-graphite/epoxy covers and graphite/epoxy substructures (spars, ribs). The present paper deals with a test program in which ultrasonic, X-ray, visual, and dimensional inspection were used to detect such flaws and defects as voids, porosity, improper cure, delamination, debond, attachments errors, dimensional errors, processing errors, and defective attach holes. The most common flaws were those detected by ultrasonic inspection. Hole defects accounted for two thirds of the final assembly defects. The reject rate was 11.8 percent. In general, the defects were handled by simple repair. Only 0.5 percent of the parts were scrapped (V P)

A79-17090 Influence and availability of maritime satellite communications and navigation J D Parker (Comite International Radio Maritime, London, England) In International Conference on Maritime and Aeronautical Satellite Communication and Navigation, London, England, March 7-9, 1978, Proceedings
London, Institution of Electrical Engineers, 1978, p 24-28 8 refs

Maritime satellite communications are discussed in terms of the Marisat system and the Marots system. The proposed evolution of a combined Marisat/Marots system into the Inmarsat program is

outlined Satellite navigation requirements are identified in terms of ocean navigation, approaching land, approaching port, and harbor and entrances The future Navstar program, using constellations of satellites in higher orbits, is described The application of maritime satellites in distress and urgency situations is considered SCS

A79-17091 An estimate of the economic benefit from a communication satellite to oceanic air traffic V W Attwooll (Civil Aviation Authority, London, England) In International Conference on Maritime and Aeronautical Satellite Communication and Navigation, London, England, March 7-9, 1978, Proceedings London, Institution of Electrical Engineers, 1978, p 29-32

This paper considers the influence that a communication satellite might have on the capacity of an oceanic air traffic system and the corresponding benefit in reduced operating cost penalty to the traffic involved The data and illustration are drawn for the North Atlantic, which has the greatest level of oceanic traffic and the most developed ATC system (though the E Pacific system approaches it) This note considers the effect of a communication satellite only, the possibilities of satellites for independent navigation or surveillance are not considered (Author)

A79-17095 Emergency position-indicating radio-beacon systems using 406 MHz band mobile-satellite service K Kimura (Ministry of Transport, Electronic Navigation Research Institute, Tokyo, Japan), M Kimura (Nippon Electric Co., Ltd., Tokyo, Japan), T Hata, and H Yoshimura (Anritsu Electric Co., Ltd., Japan) In International Conference on Maritime and Aeronautical Satellite Communication and Navigation, London, England, March 7-9, 1978, Proceedings London, Institution of Electrical Engineers, 1978, p 45-48

Attention is given to an emergency position indicating radio beacon system The system utilizes the 406-MHz band and transmits positional data derived from on-board navigational equipment to a land station via a geostationary satellite The system has been evaluated on the basis of laboratory equipment, and test results are presented It is noted that the system has a relatively simple configuration, low power consumption, and a low cost requirement for buoy implementation SCS

A79-17098 High speed digital transmission, the key for a simple Aerosat airborne equipment G David and J P Van uffelen (Telecommunications Radioelectriques et Telephoniques, Paris, France) In International Conference on Maritime and Aeronautical Satellite Communication and Navigation, London, England, March 7-9, 1978, Proceedings London, Institution of Electrical Engineers, 1978, p 57-62

High-speed digital transmission is considered in terms of channel characteristics and multipath effects Attention is given to voice encoding and data transmission, noting majority encoding combined with an error correcting code and orthogonal encoding Basic Aerosat L-band equipment is outlined in terms of its subsystems the L-band antenna, power amplifier, receiver transmit, modems, and data management SCS

A79-17118 # The proposed cryogenic European Transonic Wind Tunnel /ETW/ J P Hartzuiker (Nationaal Lucht en Ruimtevaartlaboratorium, Amsterdam, Netherlands) In Nederlandse Vereniging voor Luchtvaarttechniek, Yearbook 1977 Amsterdam, Nederlandse Vereniging voor Luchtvaarttechniek, 1978, p 1-1 to 1-21

The proposed European Transonic Wind Tunnel is described a cryogenic facility with test-section dimensions compatible with existing major European transonic facilities Reynolds number based on mean aerodynamic chord lies between 25 million and 40 million The advantages and drawbacks of cryogenic testing as well as fundamental aspects of cryogenic aerodynamics are discussed Comparative estimates for capital and operating costs are finally presented (Author)

A79-17119 # The NLR moving-base flight simulator W P Koeversmans (Nationaal Lucht en Ruimtevaartlaboratorium, Amsterdam, Netherlands) In Nederlandse Vereniging voor Luchtvaarttechniek, Yearbook 1977 Amsterdam, Nederlandse Vereniging voor Luchtvaarttechniek, 1978, p 3-1 to 3-14

Outstanding features of moving-base simulator discussed are its special motion system with low acceleration noise and threshold levels, and its adaptability to a variety of research studies through use of digital computing techniques in simulating different aircraft characteristics and use of different cockpits that can rapidly be changed The paper describes the layout of the system and the main elements of the system, which include a single-seat cockpit interchangeable with a dual transport aircraft cockpit, a four-degree-of-freedom motion system, TV model visual system with collimating display, electronic interface, digital computers, analog computer, and control desk PTH

A79-17120 # The Netherlands experimental vertical axis wind turbine J B D H Bolt (Fokker-VFW, Schiphol Airport, Netherlands) In Nederlandse Vereniging voor Luchtvaarttechniek, Yearbook 1977 Amsterdam, Nederlandse Vereniging voor Luchtvaarttechniek, 1978, p 5-1 to 5-8

The paper gives a general description of an experimental 5.3-m-diam vertical axis wind turbine and its associated power conversion system and other subsystems The two glass fiber reinforced plastic blades are strengthened by bonded light-metal plates As design-criteria for the static strength of the blades, a maximum blade rotation speed of 450 rpm in calm weather conditions and a reducing speed of 2.5 rad/sq sec at 325 rpm are used The rotor operates in two modes constant speed, and constant blade-speed/wind speed ratio Block diagrams of the mechanical-hydraulic energy conversion system and the control and protection systems are presented The test program will comprise measurement of vibration characteristics of the turbine when stationary and running, with or without tethering, measurement of turbine efficiency at constant rotor rpm and blade-speed/wind-speed ratio, measurement of tension in the blade roots, and measurement of the influence of tension in the guy wires on dynamic behavior of the turbine PTH

A79-17125 Soviet swing-wings R Braybrook *Air International*, vol 15, Dec 1978, p 266-270, 271, 272

The MiG-23 family of fighters is analyzed in some detail Attention is given to considerations that led to its development, design options, and the basic configuration Photographs of MiG-23S fighters in flight are presented BJ

A79-17146 Real-time/near real-time recce wideband data links R S Robinson (Sperry Rand Corp., Sperry Univac Defense Systems Div., Salt Lake City, Utah) In Airborne reconnaissance III /Collection and exploitation of reconnaissance data/, Proceedings of the Seminar, Washington, D C., March 28, 29, 1978

Bellingham, Wash., Society of Photo-Optical Instrumentation Engineers, 1978, p 154-163

The purpose of a data link is to move the required information over the required range, using minimum power and spectrum, with minimum distortion or alteration of the basic signal Methods of accomplishing this purpose are dependent on many factors A description is presented of key technical parameters and equipment which are significant in accomplishing this purpose Data link implementation requires proper integration of data, modulation, RF power, antenna configuration, and receiver sensitivity The link must provide signal and fade margin to ensure adequate signal-to-noise ratio as defined by sensor and display requirements The form of modulation selected affects bandwidth and transmitted power requirements Attention is given to approaches for achieving an immunity to jamming, aspects of security, the spread-spectrum concept, data compression, error correction, the interface, sensors, displays, a typical data link used for RPV flight control, miniaturization, and fiber optics GR

A79-17147 Stereovisual reconnaissance system A G Rasmussen In *Airborne reconnaissance III /Collection and exploitation of reconnaissance data/*, Proceedings of the Seminar, Washington, D C , March 28, 29, 1978 Bellingham, Wash , Society of Photo-Optical Instrumentation Engineers, 1978, p 164 169

The basic system design of the stereovisual reconnaissance system is to equip drone aircraft with instrumentation consisting of two TV cameras, related ancillary equipment, and radio link for transmitting TV signals to other airborne stations and ground station TV monitors Typical system requirements and operating criteria with general specifications are presented Consideration is given to such system elements as the airborne camera mount assembly, the TV monitor console, the delay subsystem, stereopicture storage and playback, and stereo viewing B J

A79-17211 Optical engineering of first and second generation automatic tracking/laser designator pods R E Johnson (Martin Marietta Aerospace, Orlando, Fla) In *Applications of electronic imaging systems*, Proceedings of the Seminar, Washington, D C , March 30, 31, 1978 Bellingham, Wash , Society of Photo Optical Instrumentation Engineers, 1978, p 70-78

First and second generation electrooptical pods have been designed and manufactured using a multifunction objective lens which combines apertures for a dual FOV/dual wavelength camera system, laser designator, laser ranger, and laser spot tracker A diffraction-limited telephoto objective lens with an FOV capability of 1, 1.5, and 6 deg is the heart of the optical system The engineering of the optical bed for mounting the components in the pod in a dynamic environment required detailed analysis, using both optical deflection tolerances and structural characteristics The silicon target vidicon sensor allows a unique capability for automatic in flight boresight B J

A79-17527 Northrop/United States Air Force application of failure predictions to an operational aircraft S R Murnane, L F Voorhees (Northrop Corp , Aircraft Group, Hawthorne, Calif) , and O B Davenport (USAF, Aeronautical Systems Div , Wright-Patterson AFB, Ohio) In *Fracture mechanics*, Proceedings of the Tenth Symposium on Naval Structural Mechanics, Washington, D C , September 11-13, 1978 Charlottesville, Va , University Press of Virginia, 1978, p 17-42 12 refs

The application of the principles of fracture mechanics to an operational aircraft is demonstrated and the formulation of a structural maintenance program is described In order to accomplish this purpose, the results of a complete Damage Tolerance Assessment Program conducted for the F-5E/F aircraft are utilized The primary objective of this damage tolerance assessment program is to provide improved predictions of operational life beyond which the system cannot be safely or economically operated and to establish reliable inspection procedures and safe inspection intervals Economic and service life requirements are also discussed The damage tolerance tasks are reviewed in detail in order to demonstrate how the program objectives are accomplished Recommendations for future aircraft design, based on the knowledge gained through the application of damage tolerance to the F-5E/F air vehicle, are also presented G R

A79-17542 Fracture mechanics problems for gas turbine engine structures T A Cruse (United Technologies Corp , Pratt and Whitney Aircraft Group, East Hartford, Conn) In *Fracture mechanics*, Proceedings of the Tenth Symposium on Naval Structural Mechanics, Washington, D C , September 11-13, 1978 Charlottesville, Va , University Press of Virginia, 1978, p 399-420 22 refs

One of the most critical items for flight safety is the high-pressure turbine disk due to its mass and rotational speed Thus, disk life prediction is generally the most advanced in terms of structural and fracture mechanics analysis tools Turbine airfoils are not usually flight safety components, however, engine performance including the operating temperatures and rotor speeds are closely

linked to blade durability Turbine airfoil life prediction is also rather advanced A review of the fracture mechanics problems for disks and turbine airfoils is presented In an examination of fracture mechanics problems for engine disks, attention is given to fatigue life design for inherent cracks, the characterization of buried defects, mission crack growth simulation, design fatigue life prediction, notch stress analysis requirements, microcrack initiation problems, and surface crack stress intensity factors G R

A79-17562 # Influence of fuels on the reliability of jet engines and jet aircraft Reliability with respect to fuel and lubricants (Vliianie topliv na nadezhnost' reaktivnykh dvigatelei i samoletov Khimotologicheskaya nadezhnost') V A Piskunov and V N Zrelov Moscow, Izdatel'stvo Mashinostroenie, 1978 274 p 255 refs In Russian

Data on the influence of the fuel type and composition on the performance of modern jet aircraft are reviewed, along with malfunctions associated with the properties of the fuel Recent progress in fuel research which has resulted in an upgrading of aircraft performance and reliability is discussed, and data on high-quality domestic and foreign jet fuels are presented V P

A79-17583 * A new approach to helicopter rotor blade research instrumentation V H Knight, Jr (NASA, Langley Research Center, Flight Electronics Div , Hampton, Va) In *International Instrumentation Symposium*, 24th, Albuquerque, N Mex , May 1-5, 1978, Proceedings Part 1 Pittsburgh, Pa , Instrument Society of America, 1978, p 103-111

A rotor-blade-mounted telemetry instrumentation system developed and used in flight tests by the NASA/Langley Research Center is described The system uses high-speed digital techniques to acquire research data from miniature pressure transducers on advanced rotor airfoils which are flight tested using an AH-1G helicopter The system employs microelectronic PCM multiplexer-digitizer stations located remotely on the blade and in a hub-mounted metal canister The electronics contained in the canister digitizes up to 16 sensors, formats this data with serial PCM data from the remote stations, and transmits the data from the canister which is above the plane of the rotor Data is transmitted over an RF link to the ground for real-time monitoring and to the helicopter fuselage for tape recording B J

A79-17592 A laser yaw alignment system for wind tunnels W E Anderson and R N Eversz (Northrop Corp , Aircraft Group, Hawthorne, Calif) In *International Instrumentation Symposium*, 24th, Albuquerque, N Mex , May 1-5, 1978, Proceedings Part 1 Pittsburgh, Pa , Instrument Society of America, 1978, p 223-226

In wind tunnels it is critical that the models be accurately aligned to the airflow A laser system has been devised at Northrop Corporation for aligning models to the tunnel centerline in yaw This laser yaw system eliminates the use of wires, string and plumb bobs by projecting a thin plane of light throughout the test section This plane of light is used as a reference for aligning the centerline of the model The laser system is much faster and easier to use than the old plumb bob system (Author)

A79-17593 Pressure measurements on a spinning wind tunnel model by means of telemetry A Mark (U S Army, Ballistics Research Laboratory, Aberdeen Proving Ground, Md) In *International Instrumentation Symposium*, 24th, Albuquerque, N Mex , May 1-5, 1978, Proceedings Part 1 Pittsburgh, Pa , Instrument Society of America, 1978, p 233-240 10 refs

When fired from a gun, spin stabilized projectiles experience a side force known as the Magnus force It is important to be able to describe the Magnus force on projectiles because of its destabilizing effect Within the last few years at least one U S Army projectile, the M483, had experienced flight instability because of an excessive Magnus force A description is presented of a technique for measuring the pressure distribution on spinning models, namely that of using pressure transducers and a self contained telemetry system in the rotating model It is intended to compare the measured

distributions with computations using the numerical techniques developed by Dwyer (1977) and to describe the pressure contribution to the Magnus force on projectile shapes of interest to the Army. The measurement technique is discussed in some detail together with system calibrations. G R

A79-17594 Measurement of heat transfer and forces on very high temperature models in a closed subsonic wind tunnel J F Marchman, III (Virginia Polytechnic Institute and State University, Blacksburg, Va.) In International Instrumentation Symposium, 24th, Albuquerque, N Mex., May 1-5, 1978, Proceedings Part 1 Pittsburgh, Pa., Instrument Society of America, 1978, p. 241-244. 7 refs

In 1972, in connection with plans to examine the influence of wing surface temperature on the subsonic aerodynamics of Space Shuttle vehicles, a preliminary study was conducted to determine the best means of heating models to high temperatures in the wind tunnel. The study involved heating a delta wing to temperatures of approximately 315 C and then measuring its aerodynamic properties as it cooled in the tunnel's air flow. The best series proved that it was possible to determine the aerodynamics of hot bodies in a cool subsonic flow using conventional off-the-shelf equipment and procedures at very low cost. The successful performance of the considered tests led to the conduction of similar tests on a full scale model of a Multihundred Watt Radioisotope Thermoelectric Generator package. This is a power generator for satellites. Tests carried out for a cylinder and a 65 mm diameter sphere are discussed. G R

A79-17595 Construction of a refrigerated wind tunnel with a supercooled droplet production system for research on icing P McComber, C L Phan, and J Druetz (Quebec, Universite, Chicoutimi, Canada). In International Instrumentation Symposium, 24th, Albuquerque, N Mex., May 1-5, 1978, Proceedings Part 1 Pittsburgh, Pa., Instrument Society of America, 1978, p. 245-250. Research supported by the National Research Council of Canada, Department of Education of Quebec, and Universite du Quebec.

In order to simulate icing weather conditions and to produce accumulation of glaze and rime for the purpose of doing research on icing, a refrigerated wind tunnel has been constructed at the University of Quebec at Chicoutimi. The main characteristics of the tunnel are: working section 0.6 m x 0.6 m, maximum speed 42 m/s and minimum temperature 25 C. Supercooled water droplets are produced by 6 pneumatic nozzles installed 3.5 m ahead of the test section. The closed circuit of the wind tunnel requires that the supercooled droplets be collected before they come back to the heat exchanger. Therefore, a rotating grid is installed upstream of the heat exchanger to collect ice, take it out of the tunnel and to melt it. The whole apparatus is 14 m x 7.5 m. (Author)

A79-17600 Applications of electro-optical instrumentation in turbine engine development W G Alwang (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.) In International Instrumentation Symposium, 24th, Albuquerque, N Mex., May 1-5, 1978, Proceedings Part 1 Pittsburgh, Pa., Instrument Society of America, 1978, p. 305-314. 18 refs

A brief review is presented of the types of electro-optic devices which are available for instrumentation applications, taking into account lasers and light emitting diodes, the use of the photographic process for the detection of light, other photoelectric detectors, fiber optics, modulators, and linear and angular encoders. It is pointed out that fiber optics is extensively used in gas turbine instrumentation work for devices ranging from borescopes to optical pyrometers. Applications of electro-optical instrumentation to turbine engine studies are related to temperature measurement, mechanical measurements, and flow measurement. Optical pyrometers are used for metal temperature measurements, and Raman scattering is employed for gas temperature determinations. Vibration and strain measurements can be performed with the aid of holography, speckle photography, diffraction gratings, optical sensors, reflected laser beams, and optical

heterodyning. Attention is also given to clearance and displacement measurements, holographic flow visualization, and laser velocimetry. G R

A79-17606 Wind tunnel simulation of wind-structure interactions A Kareem and J E Cermak (Colorado State University, Fort Collins, Colo.) In International Instrumentation Symposium, 24th, Albuquerque, N Mex., May 1-5, 1978, Proceedings Part 2 Pittsburgh, Pa., Instrument Society of America, 1978, p. 343-362. 48 refs. NSF Grant No. ENG-76-03135

Methods of wind-tunnel simulation of wind-structure interactions are presented. Emphasis is placed on scaling criteria for obtaining similitude between natural winds and simulated atmospheric flow in wind tunnels, the development of scale models, and the aeroelastic modeling of structures. Consideration is also given to wind tunnel instrumentation, random-data acquisition, multivariate probabilistic and spectral analysis, prediction of full scale aerodynamic loading, and response of structures from measurements taken in the wind tunnel. B J

A79-17608 Airborne video recording system W G Kindelspire (McDonnell Aircraft Co., St. Louis, Mo.) In International Instrumentation Symposium, 24th, Albuquerque, N Mex., May 1-5, 1978, Proceedings Part 2 Pittsburgh, Pa., Instrument Society of America, 1978, p. 377-384

Consideration is given to the video recording system conceived during the development of the F-15 aircraft. Used initially as a single-camera system, as an extension of existing radar maintenance techniques and as a training aid for aircrew and ground crew in radar operation and maintenance, the system now provides for pilot selectable operation of multiple cameras, singly or in combination. Ground playback equipment consists of standard commercial video reproduction machines and TV monitor. B J

A79-17609 An alternative to pseudo-tone microphones for airplane flyover noise testing E M Lowder (Douglas Aircraft Co., Long Beach, Calif.) In International Instrumentation Symposium, 24th, Albuquerque, N Mex., May 1-5, 1978, Proceedings Part 2 Pittsburgh, Pa., Instrument Society of America, 1978, p. 385-390

Current procedures for tone detection within aircraft noise spectra cannot differentiate real tones (source related) from pseudo-tones resulting from the interaction of direct and ground reflected sound waves. Consequently, ground-level microphones are used solely to demonstrate the existence of pseudo tones and thereby avoid an erroneous-tone penalty in the calculation of effective perceived noise levels. This paper shows that the cost and effort related to operating these pseudo tone microphones could be eliminated if a valid alternative method via data analysis were available. Such a technique is examined and involves the use of narrow-band spectral histories. B J

A79-17610 B-52 aircraft gross weight computational system R Brant In International Instrumentation Symposium, 24th, Albuquerque, N Mex., May 1-5, 1978, Proceedings Part 2 Pittsburgh, Pa., Instrument Society of America, 1978, p. 391, 392

Consideration is given to a microcomputer system which enables the gross weight of a B-52 aircraft to be displayed while in flight. A turbine flowmeter installed in the fuel line of each engine senses fuel flow. The microcomputer system corrects the individual flow rates for temperature, applies calibration, and computes the gross weight which is recorded on tape and displayed on the pilot's panel. Diagrams of the system are presented. B J

A79-17622 Flow field calibration results for the AEDC High Enthalpy Ablation Test Facility /HEAT/ D C Howey (Avco Corp., Avco Systems Div., Wilmington, Mass.) In International Instrumentation Symposium, 24th, Albuquerque, N Mex., May 1-5,

1978, Proceedings Part 2 Pittsburgh, Pa, Instrument Society of America, 1978, p 503-514 15 refs Contract No F33615-75-C-5185

Radial and axial pressure, heating and enthalpy surveys were made in parallel nozzle flow fields exiting from a new segmented arc heater called the Arnold Engineering Development Center (AEDC) High Enthalpy Ablation Test Facility (HEAT) Test instrumentation included null point calorimeters, transient pressure probes and a transient enthalpy probe Probe diameters ranged from 0.08 inch to 1.00 inch while run conditions included maximum chamber pressures, heat transfer rates and bulk enthalpies of 125 atm, 28000 BTU/sq ft-sec, and 4000 BTU/lb, respectively Test results are presented including comparisons with ideal flow predictions for heating, effective nose radius, pressure gradients and derived enthalpy The limitations of finite body-flow field interaction with regard to flight simulation are discussed and compared with data from other arc heaters (Author)

A79-17650 F-18 Hornet T Hamill *Flight International*, vol 114, Dec 2, 1978, p 2021-2028, 2033-2036

The F-18 Hornet aircraft, a development of the YF-17, is described The F-18, smaller than the F-4 it is designed to replace, achieves light weight by simple design, including fixed geometry intakes and unswept mainplane Several surfaces or structures are made of graphite-epoxy Powerplants, cockpit, avionics, and weapons systems are discussed Performance and the US Navy production and evaluation program are examined It is suggested that each F-18 is likely to cost about \$10 million in 1978 dollars Design modifications for the proposed land based F-18L are surveyed M L

A79-17665 # Lessons learned from the AN/ARC-164 test program A Coppola (USAF, Rome Air Development Center, Griffiss AFB, NY) In Aerospace Testing Seminar, 4th, Los Angeles, Calif, March 2, 3, 1978, Proceedings Mt Prospect, Ill, Institute of Environmental Sciences, 1978, p 103-106, Discussion, p 107-110

An extensive reliability effort, including burn-in of every unit and an all-equipment reliability test, has been performed on the AN/ARC-164 UHF airborne radio, intended as the standard airborne command transceiver for the Air Force The thermal cycles of the AN/ARC-164 burn in proved more effective than the high temperature dwell in precipitating infant mortality failures Elimination of the dwell permitted a more powerful burn-in as more cycles could be accrued in a given period of time B J

A79-17675 # Analytical designing of flight-vehicle hydraulic systems (Analiticheskoe proektirovanie gidravlicheskih sistem letatel'nykh apparatov) A M Matveenko Moscow, Izdatel'stvo Mashinostroenie, 1977 186 p 83 refs In Russian

Mathematical models of hydraulic systems used on heavy aircraft (such as airliners), supersonic aircraft, and helicopters are presented, along with parametric-analysis and synthesis methods for such hydraulic systems Generalized models of aircraft hydraulic drives are discussed, and a mathematical description of all major requirements placed on aircraft hydraulic systems is presented V P

A79-17678 Development trends in air traffic control (Entwicklungstendenzen in der Flugsicherung) H Flentje (EUROCONTROL, Brussels, Belgium) In Modern methods to safeguard traffic at sea, in the air, and on land, National Meeting, Hamburg, West Germany, October 17-19, 1978, Reports Volume 1

Dusseldorf, Deutsche Gesellschaft fur Ortung und Navigation, 1978 11 p In German

The current status of air traffic control is examined It is pointed out that a universal, uniform, well-functioning air traffic control system does not yet exist, although one of the important objectives of the International Civil Aviation Organization (ICAO) involves the worldwide establishment of rules, procedures, and techniques which will promote the safety of air traffic operations There

are, however, great differences concerning the state of the technical development of air traffic control procedures in the various member states of the ICAO Air traffic developments which are expected to take place until the year 2000 are discussed along with the development trends concerning air traffic control for the same period The Advanced Air Traffic Management System (AATMS) considered is the result of a study conducted by the US Department of Transportation The elements of the AATMS are examined, taking into account the satellite system, the Discrete Address Beacon System, the Ground Computer Area Navigation System, communication procedures, and the equipment carried by an aircraft G R

A79-17679 Experience with integrated navigation involving compensation according to the method of the least squares (Erfahrungen mit der integrierten Navigation durch Ausgleichung nach der Methode der kleinsten Quadrate) K Ramsayer (Stuttgart, Universitat, Stuttgart, West Germany) In Modern methods to safeguard traffic at sea, in the air, and on land, National Meeting, Hamburg, West Germany, October 17-19, 1978, Reports Volume 1 Dusseldorf, Deutsche Gesellschaft fur Ortung und Navigation, 1978 27 p 5 refs In German

An essential condition for increasing safety in air traffic operations is related to an enhancement of the accuracy and reliability of navigation A significantly denser air traffic without collision risks is possible if the location of an aircraft could at all times be determined with an accuracy of a few hundred meters A navigational accuracy of a few hundred meters can be obtained with special navigational aids, as, for instance, LORAN-C However, this accuracy can only be obtained in certain confined areas covered by LORAN-C Such an accuracy is not feasible when one of the currently employed systems of navigation is used by itself However, the accuracy can be significantly increased by combining the two current navigational systems with the aid of a computer to an integrated system In the described approach, a compensation procedure based on the method of the least squares is employed for the integration of the various navigational systems Good results are obtained although the computational requirements for the implementation of this approach are very low G R

A79-17680 Procedure for flight guidance in the terminal maneuvering area for an experimental program employing a flying test device (Verfahren zur Flugfuehrung im Flughafennahbereich fur ein Experimentalprogramm unter Einsatz eines fliegenden Erprobungstragers) A Modlinger (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany) In Modern methods to safeguard traffic at sea, in the air, and on land, National Meeting, Hamburg, West Germany, October 17-19, 1978, Reports Volume 1 Dusseldorf, Deutsche Gesellschaft fur Ortung und Navigation, 1978 24 p In German Research supported by the Bundesministerium fur Forschung und Technologie

It is desirable to obtain together with increasing safety a reduction in the cost of air transportation Boundary conditions are related to an increase in passenger comfort, a reduction of the stress to which the pilot is subjected in critical phases, and a reduction of the noise emitted by the aircraft An increase in operational economy with respect to fuel costs is, in the case of an automatically conducted flight, obtained by means of an appropriate calculation of the flight path Two different approach procedures, TMA1 and TMA2, were developed in this connection The characteristics of these procedures are discussed, taking into account also their verification with the aid of a digital computer program The experimental program described uses the test device for certain investigations as a 'flying simulator' A computer with a word and instruction length of 16 bits is employed G R

A79-17684 Dependence of track quality on the number of radar sensors (Abhangigkeit der Trackqualitat von der Anzahl der Radarsensoren) G Weiss (Siemens AG, Munich, West Germany) In Modern methods to safeguard traffic at sea, in the air, and on land, National Meeting, Hamburg, West Germany, October 17-19, 1978, Reports Volume 2 Dusseldorf, Deutsche Gesellschaft fur Ortung und Navigation, 1978 12 p In German

In the currently employed air space surveillance systems, a radar device is usually combined with a computer. Limitations regarding the results obtained with a single sensor can be overcome by providing a central computer with data from several radar sensors. This approach, called multiradar tracking (MRT), has a number of advantages related to a better and more reliable tracking capability. A survey of MRT procedures is presented, taking into account trace correlation and plot correlation procedures. A description of the realized MRT logic is also provided, giving attention to automatic initiation, plot processing, trace processing, and center of gravity tracking in the case of a number of flight objects moving together at close distances to each other. Simulation studies were conducted to investigate the tracking results obtained under various conditions. Preliminary results show that the plot-weighting procedure provides distinct performance improvements compared to monoradar tracking. G R

A79-17685 **Conflict warning for the radar controller in air traffic control (Konfliktwarnung für den Radarlotsen in der Flugsicherung)** W A M Janssen (EUROCONTROL, Beek, Limburg, Netherlands). In: Modern methods to safeguard traffic at sea, in the air, and on land, National Meeting, Hamburg, West Germany, October 17-19, 1978, Reports Volume 2. Dusseldorf, Deutsche Gesellschaft für Ortung und Navigation, 1978. 35 p.

The Short Term Conflict Alert (STCA) program considered is currently being developed by Eurocontrol for use at its Maastricht Upper Airspace Centre. The STCA is to provide the radar controller with a 'safety-net'. It will not interfere with his normal work. However, it will determine conditions that would lead, if these conditions were to continue, to a situation in which the distance between aircraft is less than the permitted minimum separation. Such cases would be brought to the attention of the controller to make it possible for him to take corrective action if necessary. Attention is given to the general concept of the STCA function, the principles of STCA design, aspects of trajectory prediction, conflict search algorithms, questions of conflict record management, the on-line collection of statistical data, and details of conflict display. G R

A79-17686 **The new microwave landing systems and their growth potential (Die neuen Mikrowellen-Landesysteme und ihr Wachstumspotential)** A Becker (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Braunschweig, West Germany). In: Modern methods to safeguard traffic at sea, in the air, and on land, National Meeting, Hamburg, West Germany, October 17-19, 1978, Reports Volume 2. Dusseldorf, Deutsche Gesellschaft für Ortung und Navigation, 1978. 24 p. 8 refs. In German.

A new microwave landing system (MLS) is to replace gradually the currently employed instrument landing system (ILS). Advantages of the MLS with respect to the ILS are related to a larger coverage range for angular information, higher accuracy, less susceptibility to disturbances connected with multipath propagation, smaller dimensions, and the provision of distance measurements by the system itself. System proposals made by various countries are evaluated to obtain a basis for the selection of the most appropriate system. A very important factor in the evaluation is the growth potential of the system. The characteristics of the competing systems are discussed together with their growth potentials. G R

A79-17687 **The economic superiority of integrated navigation systems, represented for MILECS (Die wirtschaftliche Überlegenheit integrierter Navigationssysteme dargestellt am MILECS)** K D Eckert (Standard Elektrik Lorenz AG, Stuttgart, West Germany). In: Modern methods to safeguard traffic at sea, in the air, and on land, National Meeting, Hamburg, West Germany, October 17-19, 1978, Reports Volume 2. Dusseldorf, Deutsche Gesellschaft für Ortung und Navigation, 1978. 12 p. In German.

The significance of radionavigation for air traffic in the air space of Central Europe is discussed. The variety and complexity of the problems which have to be solved have led to a corresponding variety

of solutions. It is pointed out that the entire situation is far from optimal. Operational and safety related requirements are satisfied. However, it appears certain that the demand for an optimal degree of operational economy has not been fulfilled. Improvements regarding, at least a few functions, can be obtained by introducing integrated systems. Such systems provide decisive advantages with respect to economical and other considerations. The Microwave Integrated Landing/Enroute Navigation and Air Traffic Control System (MILECS) is an integrated system which uses only a few ground installations and one onboard device for nearly all radio guidance tasks that are performed in the TMA-range. The integration of the operational tasks solves the economic problem without any impairment of system integrity. The considered approach makes even an enhancement of system performance possible. G R

A79-17688 **Position determination and path tracking system using stationary ground based radio networks (Positionserfassungs- und Bahnverfolgungssystem unter Verwendung fester erdgebundener Funknetze)** F Sender (Prakla Seismos GmbH, Hanover, West Germany). In: Modern methods to safeguard traffic at sea, in the air, and on land, National Meeting, Hamburg, West Germany, October 17-19, 1978, Reports Volume 3. Dusseldorf, Deutsche Gesellschaft für Ortung und Navigation, 1978. 25 p. In German.

Radio-determination systems represent currently the economically most favorable solution for the considered vehicle position determination and path tracking tasks. The approaches used in radio determination systems are examined. The employment of radar devices is essentially limited to applications related to air space surveillance and the observation of sea and harbor areas. A number of methods are based on an operation in the ultrashort wave and microwave region. The range of these methods is restricted to the theoretical line of sight distance. The accuracy is from good to very good. Other methods utilize for their operation the medium frequency and low frequency band. The range in the case of these methods is very large. Range limitations exist only during the night. The accuracy is from medium to good. The methods based on the use of the medium frequency and low frequency band are in principle well suited for a universal range of applications. However, a number of difficulties have to be overcome before a satisfactory operation is possible. Suitable approaches for doing this are discussed. G R

A79-17689 **Large-area information display using digital laser beam deflection (Grossflächige Informationsdarstellung mittels digitaler Laser-Strahlableitung)** F Kunz (Philips Elektro Spezial GmbH, Bremen, West Germany). In: Modern methods to safeguard traffic at sea, in the air, and on land, National Meeting, Hamburg, West Germany, October 17-19, 1978, Reports Volume 3. Dusseldorf, Deutsche Gesellschaft für Ortung und Navigation, 1978. 18 p. In German.

The cathode ray tube, which is widely used for display applications, is not well suited to satisfy requirements for bright, large scale displays. Such displays are used in control and guidance systems maintained by the public sector and by private firms. The most important requirements regarding the considered displays are related to a screen with an area of 4×4 sq m, a high brightness level, an image resolution which is better than that in conventional television systems, and good contrast characteristics. Development work for implementing such displays with the aid of an approach involving digital laser beam deflection was started in an industrial research laboratory in Germany in 1966. A description is presented of the principles of operation of the developed laser displays, their integration in data transmission systems, and their industrial status. G R

A79-17690 **Comparison of safety principles in aviation and in track-guided traffic (Gegenüberstellung der Sicherheitsprinzipien in der Luftfahrt und im spurgeführten Verkehr)** H Fricke (Braunschweig, Technische Universität, Braunschweig, West Germany). In: Modern methods to safeguard traffic at sea, in the air, and on land, National Meeting, Hamburg, West Germany, October 17-19,

1978, Reports Volume 3 Dusseldorf, Deutsche Gesellschaft für Ortung und Navigation, 1978 22 p In German

The concept of safety in traffic is examined. An evaluation of the existing safety level requires a study of the entire transportation process. The particular safety principles found in aviation are considered. Approaches for the enhancement of safety in aviation are based on an increase in reliability to reduce the number of dangerous defects. A further increase in reliability is obtained in connection with advances in electronics related to very large scale integration and the use of microcomputers with word lengths of 16 bits. A decisive difference between aviation and track-guided traffic with respect to safety considerations is related to the possibility that track-guided vehicles can occupy a safe state by remaining without motion in a stopped condition. The implementation of one channel and two-channel fail-safe techniques is discussed. G R

A79-17692 Direction finders in the service of safety for air and sea traffic (Peiler im Dienst der Sicherung des Luft- und Seeverkehrs) B F Ernst (Rohde und Schwarz, Munich, West Germany). In: Modern methods to safeguard traffic at sea, in the air, and on land, National Meeting, Hamburg, West Germany, October 17-19, 1978, Reports Volume 3 Dusseldorf, Deutsche Gesellschaft für Ortung und Navigation, 1978 11 p 5 refs In German

A description is presented of that part of radio direction finding technology which is concerned with the surveillance and the safety of air and sea traffic on the basis of operational processes using stationary ground stations. Radio direction finders used for traffic control applications must function automatically and reliably and must provide accurate data even under unfavorable reflection conditions. The operation of the direction finders currently used, which satisfy these requirements, is based on the Doppler principle. Modern direction finders employ a frequency compensation method to eliminate errors produced as a consequence of a change in signal frequency. Details regarding the use of direction finders in air traffic are discussed. Problems related to the employment of direction finders in maritime traffic are also examined. Some of these problems will be solved in connection with the introduction of new direction finding installations with a greater accuracy which are currently being developed. G R

A79-17693 Automatization in air traffic control - Planning for the 1980s within the province of the Federal Institute of Air Traffic Control (Automatisierung in der Flugverkehrskontrolle - Planung für die 80er Jahre im Bereich der Bundesanstalt für Flugsicherung) K Platz (Bundesanstalt für Flugsicherung, Frankfurt am Main, West Germany). In: Modern methods to safeguard traffic at sea, in the air, and on land, National Meeting, Hamburg, West Germany, October 17-19, 1978, Reports Volume 3 Dusseldorf, Deutsche Gesellschaft für Ortung und Navigation, 1978 19 p In German

The significance of the Federal Republic of Germany in commerce and the geographic location of this state lead to a high volume air traffic in the civil and the military sector. The limited area involved in connection with the existing peculiar military-geographical conditions is the cause for an air traffic with a very complex structure. The Federal Institute of Air Traffic Control in Germany has been given the task to provide the conditions for a safe, orderly, and regular performance of the air traffic. The organizational basis for the required air traffic control operations is discussed, taking into account the geographical subdivision of the total area for the surveillance operations, 10 temporarily reserved areas for military flights, six danger areas, 34 areas for which flights are subjected to certain restrictions, and eight areas with restrictions related to visibility conditions. Planning objectives for the 1980s are related to a maintenance of safety in the face of increasing air traffic, the adaptation of the flight safety capacity to the increasing requirements, and the optimal utilization of the air space. G R

A79-17694 Display of flight plan information on electronic data display devices - A means for the enhancement of the capacity in air traffic control (Darstellung von Flugplaninforma-

tionen auf elektronischen Datensichtgeräten - Ein Mittel zur Erhöhung der Kapazität in der Flugverkehrskontrolle) K Dittmar (Bundesanstalt für Flugsicherung, Frankfurt am Main, West Germany). In: Modern methods to safeguard traffic at sea, in the air, and on land, National Meeting, Hamburg, West Germany, October 17-19, 1978, Reports Volume 3 Dusseldorf, Deutsche Gesellschaft für Ortung und Navigation, 1978 21 p 5 refs In German

The effects of automatization on the work of the controller are examined and a description is presented of the requirements and concepts with respect to the display of the data and the input and output media. The flight plan as the control basis is considered and possibilities for enhancing the control capacity are discussed, taking into account the establishment of parallel routes, the redistribution of competence areas, speed regulations, and the employment of additional controllers. The use of electronic display devices for the presentation of flight plan and flight progress data as replacement for the control tape procedure appears necessary for a number of reasons. The implementation of plans for such a replacement is discussed, giving attention to approaches for overcoming certain difficulties. G R

A79-17696 Investigation for planning the approach traffic (Untersuchung zur Planung des Anflugverkehrs) A Seyfried (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Braunschweig, West Germany). In: Modern methods to safeguard traffic at sea, in the air, and on land, National Meeting, Hamburg, West Germany, October 17-19, 1978, Reports Volume 3 Dusseldorf, Deutsche Gesellschaft für Ortung und Navigation, 1978 24 p 7 refs In German Deutsche Forschungsgemeinschaft Contract No. SFB 58

In connection with the steady increase in the volume of air traffic, it becomes apparent that the current capacity of the air traffic control system will not be adequate for the volume of air traffic which has to be expected for the future. The capacity limits of the air traffic control system are determined by technical and operational factors and by limits regarding the stress to which the controllers can be subjected. The highest stress levels are found in connection with control activities in the approach area of an airport. A relief in this case appears, therefore, the most urgent task. Approaches for providing such a relief are investigated, taking into account a study of the air traffic in the airport of Frankfurt, controller interviews, and direct observations at the control location. Attention is given to the possibility to transfer the planning function to a computer system which in on-line operation can assist the controller in his work. G R

A79-17767 On the noise emitted by cold subsonic coaxial jets (Bruit de jets coaxiaux froids subsoniques) D Juve, J Bataille, and G Comte Bellot (Lyon, Ecole Centrale, Ecully, Rhône, France). *Journal de Mécanique Appliquée*, vol 2, no 3, 1978, p 385-398 17 refs In French Direction des Recherches et Moyens d'Essais Contract No. 73/737

The aeroacoustic properties of cold subsonic coaxial jets are investigated for two area ratios. It is shown that the sound level produced by the coaxial configuration is much lower than that of a realistic reference jet. An empirical model of the acoustic radiation is given which is in good agreement with the experimental trends.

(Author)

A79-17769 Genesis of the European high-Reynolds number transonic wind tunnel project (Genèse du projet de soufflerie transsonique européenne à grand nombre de Reynolds) J Christophe (ONERA, Châtillon sous Bagneux, Hauts de Seine, France). *Association Aéronautique et Astronautique de France, Colloque d'Aérodynamique Appliquée*, 14th, Toulouse, France, Nov 7-9, 1977. *L'Aéronautique et l'Astronautique*, no 72, 1978, p 21-34 40 refs In French

The proposed cryogenic wind tunnel project, which would involve cooperation by West Germany, France, the Netherlands, and the United Kingdom, is described. Reasons for performing high Reynolds number experiments are discussed, and examples of pro-

posed problems and their analysis are examined. Reasons for selecting the cryogenic design are considered with attention to the history of the wind tunnel project and the performance of pilot-study wind tunnels. M L

A79-17771 **Three years use of Mercury - Technical balance sheet (3 ans d'exploitation du Mercure - Bilan technique)** D Cauvin, G Jehl, and D Desormiere (Air Inter, Paris, France) *L'Aéronautique et l'Astronautique*, no 72, 1978, p 61-68. In French.

Performance of the 10 Mercury aircraft is examined in terms of reliability and maintenance. It is concluded that the aircraft fulfilled the goals of the design program. Technical problems were comparable to those of similar planes designed at the time. The cost of maintenance is considered and is compared with the costs of maintaining the B 727. M L

A79-17965 **The application of reinforced plastics to the emergency repair of aircraft** K F Rogers, D M Kingston-Lee, and L N Phillips (Royal Aircraft Establishment, Materials Dept, Farnborough, Hants, England). In *Jointing in fibre reinforced plastics*, Proceedings of the Symposium, London, England, September 4, 5, 1978. Guildford, Surrey, England, IPC Science and Technology Press, Ltd., 1978, p 104-115. 5 refs.

The development of glass-carbon hybrid woven fabrics has made it possible to produce reinforced plastics with strengths and moduli comparable to those of light alloys. It is shown that these fabrics, when applied to a light alloy substrate by wet laminating methods using fast-curing epoxy resins, can give bond strength equivalent to those obtained by rivetting, and thus have potential for the emergency repair of damaged aircraft. Typical repairs to aircraft skin components are described and the results of tensile evaluations are reported. Preliminary work on the repair of carbon fibre reinforced laminates by the adhesive bonding of preformed carbon fibre composite patches is also reported. (Author)

A79-18001 **The use of wing tip sails to reduce vortex drag** J J Spillman (Cranfield Institute of Technology, Cranfield, Beds., England) *Aeronautical Journal*, vol 82, Sept 1978, p 387-395. 10 refs.

Results are examined for wind tunnel studies of the flow behind the tip of an unswept wing of moderate aspect ratio. Effects of wing-tip sails on the drag of an aircraft are analyzed, wind-tunnel tests on sails mounted from tip tanks are discussed, and flight tests with sails on tip tanks are described, along with wind-tunnel tests on a model aircraft with plain wing tips. The effectiveness of sails in reducing the lift-dependent drag factor is evaluated. It is shown that sails fitted to the wing tips of an aircraft can reduce its lift dependent drag by up to 30% and that three or four sails per wing tip, each having a span of about 0.25 of the wing tip chord and a root chord of about 16% of that of the wing tip, appear to give the greatest vortex drag reduction when fitted, almost horizontally, outboard of the rear half of the wing tip. F G M

A79-18004 **Airworthiness of helicopters /Cierva Memorial Lecture/** H E Le Sueur (Civil Aviation Authority, London, England) *Aeronautical Journal*, vol 82, Oct 1978, p 411-416.

The airworthiness of helicopters is discussed with respect to items that are likely to fail, viz., the structure, engine, transmission, and any of several aircraft systems such as controls, hydraulics, electronics, and radio. Attention is given to rotor fatigue strength, the strength of other structural elements, stiffness, vibration, helicopter performance, engine powers, transmission maintenance, control-system problems, prevention of power-plant and electrical-system failure, helicopter ditching, failure analysis, operation under conditions requiring the use of instruments, and problems with icing. It is noted that if nearly 1000 aircraft are built and a number of that type exceed 10,000 flying hours, the probability of failure is of the order of 1 in 10 million. F G M

A79-18007 **A compliant wall, supersonic wind tunnel** E H Dowell (Princeton University, Princeton, N.J.) *Aeronautical Journal*, vol 82, Oct 1978, p 448-451. Grant No. AF AFOSR 77 3337.

The concept of the self-correcting wind tunnel is broadened to allow at least the magnitude of the wall shape to vary with flow conditions, e.g., flow dynamic pressure. Two-dimensional supersonic flow is considered in the context of small perturbation theory, and the compliant wall is modeled as rigid hinged segments whose compliance is determined by attached springs. Single segments with the hinge at the leading edge or at the trailing edge are investigated, conditions for zero wall interference are obtained, and the generalization to multiple wall segments that would be required for an airfoil with arbitrary downwash is briefly outlined. The analysis indicates that a wall segment with a leading-edge hinge is more promising than one with a trailing-edge hinge because the latter is subject to aeroelastic divergence and that a compliant wall wind tunnel shows real promise as a concept for reducing wind-tunnel wall interference. F G M

A79-18096 **The air-superiority fighter** D Richardson and G Warwick *Flight International*, vol 115, Jan 6, 1979, p 15-18, 23-25.

It is pointed out that air superiority is not a role or mission but a state of affairs. The air force which has such superiority can maintain control of the airspace over a battle area, fending off attacks by enemy strike aircraft while keeping hostile fighters off the tail of its own strike formations. The classical air superiority fighter is a highly maneuverable aircraft capable of 'mixing it' in close combat. But long-range air-to-air missiles are no respecters of such qualities. A description is, therefore, also given of some specialized interceptors which although not primarily intended for close-range dogfighting, could be used to win and hold air-superiority. A good air superiority fighter must excel in three areas related to the detection of targets, maneuverability, and weaponry. The characteristics of a successful fighter are examined and an evaluation is conducted of the various fighter aircraft currently available with respect to these characteristics. G R

A79-18127 * **Analytic investigation of advancing blade drag reduction by tip modifications** M E Tauber (NASA, Ames Research Center, Moffett Field, Calif.) In *American Helicopter Society, Annual National Forum*, 34th, Washington, D.C., May 15-17, 1978, Proceedings. Washington, D.C., American Helicopter Society, 1978. 10 p. 13 refs. (AHS 78 01)

Analytic techniques were applied to study the effect on the performance of the nonlifting advancing blade when the outboard 5% of the blade is modified to reduce drag. The tip modifications studied consisted of reducing airfoil thickness, sweepback, and planform taper. The reductions in instantaneous drag and torque were calculated for tip speed ratios from about 0.19 to 0.30, corresponding to advancing blade tip Mach numbers of 0.855 to 0.936, respectively. Approximations required in the analysis introduce uncertainties into the computed absolute values of drag and torque, however, the differences in the quantities should be a fairly reliable measure of the effect of changing tip geometry. For example, at the highest tip speed, instantaneous drag, and torque were reduced by 20% and 24%, respectively, for tip sweep of 40 deg on a blade using an NACA 0010 airfoil and by comparable amounts for 30-deg sweep on a blade having an NACA 0012 airfoil section. The present method should prove to be a useful, inexpensive technique for identifying promising configurations for additional study and testing. (Author)

A79-18128 **What are the lift and propulsive force limits at high speed for the conventional rotor** F J McHugh (Boeing Vertol Co., Philadelphia, Pa.) In *American Helicopter Society, Annual National Forum*, 34th, Washington, D.C., May 15-17, 1978, Proceedings. Washington, D.C., American Helicopter Society, 1978. 13 p. 8 refs. (AHS 78 02)

The paper describes wind tunnel tests conducted to investigate the lift and propulsive force limits of the conventional rotor in

high-speed regime at advance ratios between zero and 0.64. Also investigated was the effect of approaching the lift limits on performance, blade loads, and rotor control power. The tests showed that the conventional rotor can operate in high speed forward flight at useful levels of lift without auxiliary lift or auxiliary propulsion. P T H

A79-18129 * # Full-scale wind tunnel test of a modern helicopter main rotor - Investigation of tip Mach number effects and comparisons of four tip shapes. R. H. Stroub (NASA, Ames Research Center, U.S. Army, Aeromechanics Laboratory, Moffett Field, Calif.) In American Helicopter Society, Annual National Forum, 34th, Washington, D.C., May 15-17, 1978, Proceedings. Washington, D.C., American Helicopter Society, 1978. 7 p. (AHS 78-03)

A test of a full scale helicopter rotor was conducted in the NASA Ames Research Center 40- by 80 Foot Wind Tunnel to investigate performance characteristics of rotors with various tip geometries. Four blade tip geometries were investigated: rectangular, trapezoidal, swept rectangular, and swept trapezoidal. The investigation was accomplished over an advance ratio range of 0.2 to 0.375 and an advancing blade Mach number range from 0.72 up to 0.97. On a power basis, the best overall tip geometry was the swept trapezoidal configuration. (Author)

A79-18130 Full-scale wind tunnel tests of a modern helicopter main rotor - Correlation with model rotor test data and with theory. D. T. Balch (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.) In American Helicopter Society, Annual National Forum, 34th, Washington, D.C., May 15-17, 1978, Proceedings. Washington, D.C., American Helicopter Society, 1978. 9 p. (AHS 78-03B)

Results of full scale testing of a 44-ft diameter advanced geometry rotor are compared with wind tunnel tests on a 1/5 scale model. Differences between model and full scale results are presented in terms of the model rotor torque corrections necessary to account for Reynolds number effects. It was found that if a CQ/σ increment of 0.0004 were to be subtracted from the measured power levels of the 1/5 model rotor, a close approximation to the performance of the full scale rotor would result. P T H

A79-18131 Rotor airfoil optimization - An understanding of the physical limits. L. Dadone (Boeing Vertol Co., Philadelphia, Pa.) In American Helicopter Society, Annual National Forum, 34th, Washington, D.C., May 15-17, 1978, Proceedings. Washington, D.C., American Helicopter Society, 1978. 16 p. 18 refs. (AHS 78-04)

The paper surveys the progress in rotor airfoil design with emphasis on the sectional performance. Key sectional characteristics are identified and the possibilities for improved performance are discussed. Some results of the study are the following: beneficial transonic effects can be expected to influence the maximum lift capability of airfoils operating at Mach numbers beyond 0.5, below $M = 0.4$ the local supersonic region is too small to be considered a design variable. Nose-up pitching moment compensation is detrimental to high-priority characteristics such as maximum lift capability, drag divergence, and profile drag. New transonic analysis codes can be used to verify the presence of transonic characteristics which will improve the maximum lift beyond the level predicted by a subcritical analysis. P T H

A79-18132 * # Rotor-airfoil flight investigation - Preliminary results. C. E. K. Morris, Jr. (NASA, Langley Research Center, Hampton, Va.) In American Helicopter Society, Annual National Forum, 34th, Washington, D.C., May 15-17, 1978, Proceedings. Washington, D.C., American Helicopter Society, 1978. 13 p. 24 refs. (AHS 78-05)

A flight investigation has been conducted to study the behavior of three advanced-technology airfoils in the three-dimensional, unsteady-flow environment of the helicopter main rotor. Three sets of instrumented main-rotor blades were flown on an AH-1G

helicopter. Each set employed one of three airfoils developed with significantly different design technologies. Data are given on performance, rotor loads, and the measurements of chordwise pressure distribution at 90 percent blade radius. The pressure data are compared with theoretical distributions calculated for two-dimensional, steady flow. (Author)

A79-18133 Aerodynamic design of the Sikorsky S-76 helicopter. E. A. Fradenburgh (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.) In American Helicopter Society, Annual National Forum, 34th, Washington, D.C., May 15-17, 1978, Proceedings. Washington, D.C., American Helicopter Society, 1978. 15 p. 6 refs. (AHS 78-06)

The Sikorsky S-76 twin engine commercial helicopter incorporates advanced aerodynamic design features that contribute substantially to its excellent performance capabilities. It is fast and agile but is also quiet and efficient, with high lift capability per unit of installed power and very long range. The fact that the aircraft meets or exceeds the performance targets selected at the beginning of the program is attributed to a conservative tailoring of the rotor design parameters and to an unusually low level of parasite drag. (Author)

A79-18134 Design and development tests of a four-bladed light helicopter rotor system. W. L. Cresap, A. W. Myers, and S. P. Viswanathan (Bell Helicopter Textron, Fort Worth, Tex.) In American Helicopter Society, Annual National Forum, 34th, Washington, D.C., May 15-17, 1978, Proceedings. Washington, D.C., American Helicopter Society, 1978. 11 p. 7 refs. (AHS 78-07)

A four-bladed, soft inplane rotor of composite construction has been designed and flight tested on a 206L prototype helicopter as part of the continuing research and development effort of Bell Helicopter Textron. In the first 10 months of operation, 300 hours of flight have been accumulated. These encompassed both development tests and service suitability evaluations in high altitude, cold weather, and desert environments. Measurements during flights to 169 mph and maneuvers to 2.6g indicate the hub and blades have unlimited fatigue lives. Vibrations are low throughout the helicopter flight envelope. High altitude tests show the rotor to provide exceptionally good autorotative characteristics. Cold weather evaluation has demonstrated trouble-free operation to 26 F, while desert environmental tests show little or no erosion of the blades after 500 landings and takeoffs. This program has confirmed Bell's technical predictions and provides an additional option in offering a rotor system for every specific mission. (Author)

A79-18135 The sizing of a V/STOL aircraft for multi-mission application. J. W. Spencer (Rockwell International Corp., Columbus Aircraft Div., Columbus, Ohio.) In American Helicopter Society, Annual National Forum, 34th, Washington, D.C., May 15-17, 1978, Proceedings. Washington, D.C., American Helicopter Society, 1978. 10 p. (AHS 78-09)

In order to establish the optimum design characteristics for a multi-mission V/STOL aircraft, scenarios have been developed for operational employment of multi-mission Type A V/STOL aircraft in the 1990 time period. The study sequence is (1) establish typical naval situations in which the Type A variants would be used, (2) estimate threat parameters and ship basing options, and (3) develop parametric relationships between aircraft size, mission parameters, and effectiveness. This approach is applied to antisubmarine warfare and airborne early warning applications. P T H

A79-18136 High-performance VTOL for over-the-horizon targeting. R. F. Schwoerer (Grumman Aerospace Corp., Bethpage, N.Y.) In American Helicopter Society, Annual National Forum, 34th, Washington, D.C., May 15-17, 1978, Proceedings. Washington, D.C., American Helicopter Society, 1978. 11 p. (AHS 78-10)

This paper presents an evaluation of manned and remotely piloted high-performance VTOL designed to operate from small surface combatants and provide over-the-horizon (OTH) targeting for

surface to-surface cruise missiles. Three system concepts are considered: a manned aircraft operating alone, a manned aircraft operating in conjunction with a remotely piloted vehicle (RPV), and two RPVs operating together. Representative mission loads are established for each vehicle. Mission requirements, in terms of radius and time-on station, are derived according to the size and range of the target's uncertainty area. Vehicle takeoff gross weights (TOGW) compatible with operations from small combatants and system life-cycle costs (LCC) are determined to satisfy the mission requirements. The three OTH targeting system concepts are compared on the basis of LCC for equal effectiveness and the advantages and disadvantages of each are summarized. (Author)

A79-18138 * **Rotor Systems Research Aircraft /RSRA/ Emergency Escape System** L J Bement (NASA, Langley Research Center, Hampton, Va.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings. Washington, D C, American Helicopter Society, 1978. 11 p. Army NASA-sponsored research. (AHS 78-12)

The three man Rotor Systems Research Aircraft (RSRA) Emergency Escape System, the first system known to be fully qualified and operational in a rotary wing aircraft, will have two modes of operation: one providing for full in-flight egress, and the other for the severance of the rotor blades for a return to base as a fixed-wing aircraft. This paper describes the escape system's design principles, integration into the aircraft, qualification, and performance. (Author)

A79-18139 **Helicopter combat mission simulator** R J Milelli and R D Monroe (Martin Marietta Aerospace, Orlando, Fla.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings. Washington, D C, American Helicopter Society, 1978. 11 p. (AHS 78-13)

A helicopter simulator has been developed by Martin Marietta to support in-house development efforts on the advanced attack helicopter and other advanced helicopter systems. The simulator is designed to provide a realistic environment, including low-level flight at night, which is required to effectively evaluate advanced avionics and fire control systems in man-in-the-loop studies. The mechanization of the simulation is described as well as its capabilities and limitations. Qualitative results and observations from the initial simulation conducted during the months of September and October of 1977 are presented. In addition, future plans for the simulation facility are noted. (Author)

A79-18140 **Multiplex system for the Hughes advanced attack helicopter - YAH-64** F Booth (Hughes Helicopters, Culver City, Calif.) and D Espen (Sperry Flight Systems, Phoenix, Ariz.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings. Washington, D C, American Helicopter Society, 1978. 9 p. (AHS 78-14)

The YAH-64 helicopter uses a multiplexing system to transfer data and provide controls for avionics and mission equipments. The multiplex system makes extensive use of monolithic and hybrid components, including integrated automatic built-in test circuitry and system redundancy. Significant multiplex operational characteristics include distributed time division multiplex system, redundant 1 megabit data bus system with all data code in a self-clocking bilevel Manchester format, primary and backup bus controllers, BIT to isolate 95% of functional failures, and integral fault detection and location system. P T H

A79-18141 **Fly-by-wire for vertical lift** B L McManus (Boeing Vertol Co., Philadelphia, Pa.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings. Washington, D C, American Helicopter Society, 1978. 21 p. 9 refs. (AHS 78-15)

The paper presents concepts relating to fly-by-wire flight control system design for vertical lift aircraft. Overall system options considered include the central computer concept, where both pilot and stabilization signals are handled in the same computer. In the primary-automatic control concept, a direct link exists between the pilot and actuators. The automatic flight control system provides stability and control augmentation and mission-related functions. The linkage must be redundant, and two approaches to redundancy management are the quadruplex cross-channel monitor and the triplex in-line monitor. A 4-axis fingerball sidearm controller is discussed that has three response modes. Digital and analog computation are compared with respect to safety and reliability, weight, and power consumption. Experience with the demonstrator flight control system for the HLH (heavy lift helicopter) is described. P T H

A79-18142 **Pilot night vision system /PNVS/ for advanced attack helicopter /AAH/** C M Tsoumbanos (U S Army, Avionics Research and Development Activity, Fort Monmouth, N J.) and M B Kelley (U S Army, Night Vision and Electro Optical Laboratory, Fort Belvoir, Va.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings. Washington, D C, American Helicopter Society, 1978. 13 p. 5 refs. (AHS 78-16)

The paper describes the advanced attack helicopter (AAH) pilot night vision system (PNVS) and associated equipment and their integration for providing the YAH-64 pilot a night NOE mission and fire control capability. The pilot sees at night through the use of forward-looking infrared (FLIR). The FLIR instantaneous field of view is 30 x 40 degrees, but the turret-mounted FLIR can be slewed. Attention is given to the symbology formats and distribution, the symbology generator interface, and the integrated helmet and display sighting system. The multiplex data bus interface and the pilot's fire control panel are shown, and the various subsystem interfaces are briefly described. P T H

A79-18143 **A versatile approach to cockpit management** H J Nieuwsmma and R L Cramer (Rockwell International Corp., Collins Government Avionics Div., Cedar Rapids, Iowa.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings. Washington, D C, American Helicopter Society, 1978. 7 p. (AHS 78-17)

A family of cockpit management systems (CMS) was developed to reduce helicopter crew workload, reduce cockpit space requirements, minimize installation weight, and provide the versatility to respond to changes in avionics complement. The intent of the CMS is to provide integrated control and display capability for all the avionics with a universal control panel. The paper presents the architecture of the CMS and shows how a 75% reduction in space requirements was obtained along with the capability of providing each crew member control of all avionics. P T H

A79-18144 **Development of a solid state vertical instrument display system** T B Meek, Jr (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings. Washington, D C, American Helicopter Society, 1978. 7 p. (AHS 78-18)

The rationale for the selection of vertical instrument displays for the BLACK HAWK helicopter is briefly presented as background. The instrument system is described. The paper then describes the problems encountered with integrating the state-of-art solid state indicator system into the helicopter during its design and development program. Problems specifically described are uniformity of displays, insufficient cues from the triple tachometer and engine torque indicators, misreading of indicator scales and digital readouts, lamp reliability, and interfaces between the indicator displays and the sensors. (Author)

A79-18145 A comparison of predicted and experimental rotor loads to evaluate flap-lag coupling with blade pitch R E Hansford (Westland Helicopters, Ltd, Yeovil, Somerset, England) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings

Washington, D C, American Helicopter Society, 1978 14 p 14 refs Research supported by the Ministry of Defence (Procurement Executive) (AHS 78-19)

The structural coupling between flap and lag motions due to blade pitch rotation is incorporated into a rotor load prediction program, and results of analysis using coupled flap-lag mode shapes are compared with experimental blade bending data Agreement between predicted and measured rotor loads was worsened by the inclusion of structural flap-lag coupling effects This was due to large variation of coupled flap-lag modal components with pitch perturbations Depending on the choice of modal coordinates, either inertial or structural couplings are predicted These couplings lead to diametrically opposite results for modal frequency variation with blade pitch, so care should be exercised to ensure that the dynamical model represents the coupling characteristics of the given rotor

P T H

A79-18146 Environmental vibration testing of helicopter stores and equipment to the procedures outlined in MIL-STD-810C D P Schrage and R H Lutz (U S Army, Aviation Research and Development Command, St Louis, Mo) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings Washington, D C, American Helicopter Society, 1978 12 p 12 refs (AHS 78-20)

The MIL-STD 810C environmental vibration test requirements for internal and external equipment installed on helicopters are presented Shortcomings in these requirements and how they can result in unnecessary weight and cost penalties during design without producing reliable performance under realistic conditions are discussed Emphasis is placed on the application of the test-fix test philosophy during engineering development Examples of its application to two current store development programs are explained and test results presented Recommended changes to MIL-STD-810C are made and the need for innovative engineering solutions to current problems are discussed (Author)

A79-18147 # An aeromechanical stability analysis for bearingless rotor helicopters D H Hodges (U S Army, Aeromechanics Laboratory, Moffett Field, Calif) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings Washington, D C, American Helicopter Society, 1978 20 p 32 refs (AHS 78-21)

An analysis, developed primarily for analyzing the aeromechanical stability of bearingless rotor helicopters in hover (air resonance) and on the ground (ground resonance), is presented The flexbeam portion of the rotor blade is treated in detail while the simplicity of rigid-body dynamics is retained for the fuselage and outboard portion of the rotor blade The analysis is also capable of analyzing various types of pitch-control systems and treats implicitly the aeroelastic couplings that arise from pitch control geometry, the equilibrium deflected shape of the flexbeam, and the built in angular offsets of the blade and flexbeam Numerical results are obtained to compare with experimental data for two small-scale models to examine the accuracy and limitations of the analysis One model is equipped with a simplified hingeless rotor without a pitch bearing or pitch-control system The correlation is excellent and serves to verify the accuracy of the rigid-body dynamics and the aerodynamics The other model is a 1/5 86 Froude-scaled BO-105 specially equipped with a bearingless main rotor, the correlation is generally good

(Author)

A79-18148 Examination of the air resonance stability characteristics of a bearingless main rotor R P White, Jr, L R Sutton (Systems Research Laboratories, Inc, Newport News, Va), and W E Nettles (U S Army, Applied Technology Laboratory, Fort Eustis, Va) In American Helicopter Society, Annual National

Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings Washington, D C, American Helicopter Society, 1978 13 p 6 refs (AHS 78-22)

The Rotor Aeroelastic Response Analysis (RARA) and Helicopter Aeroelastic Stability Analysis (HASTA) programs were used to investigate the air resonance characteristics of a bearingless main rotor system (BMR) system A full-scale model was used as the base-line system configuration Values for parameters such as precone at hub, predroop at blade root, blade retention beam orientation, and beam to blade pitch discontinuity were assigned System characteristics studied included rotor rotational speed, retention beam pitch orientation, mean elastic blade coning deformation, shaft-pylon stiffnesses, and blade edgewise frequency

P T H

A79-18149 Sikorsky S-76 analysis, design, and development for successful dynamic characteristics C Niebanck (United Technologies Corp, Sikorsky Aircraft Div, Stratford, Conn) and W Girvan (United Technologies Corp, Sikorsky Aircraft Div, West Palm Beach, Fla) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings Washington, D C, American Helicopter Society, 1978 18 p 8 refs (AHS 78-23)

The procedure to achieve successful dynamic properties for the S-76 helicopter consisted of (1) analysis to appropriate level of sophistication to guide design in pretest stage, (2) application of semi empirical methods to augment analysis, (3) provision in design for relatively simple changes which improve or tune dynamic properties as required, (4) component or partial aircraft testing in the preflight stage where practical for early verification of acceptable design, (5) full-scale wind tunnel testing of flight-similar rotor systems, and (6) final dynamic tuning during development flight testing The application of these principles is reviewed in terms of main rotor dynamics, tail rotor dynamics, ground resonance, compatibility of rotor-drive system with engine, and vibration control

P T H

A79-18150 Antiresonant rotor isolation for vibration reduction R A Desjardins and W E Hooper (Boeing Vertol Co, Philadelphia, Pa) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings Washington, D C, American Helicopter Society, 1978 12 p 14 refs (AHS 78-24)

The improved rotor isolation system (IRIS) consists of four vertical units which provide isolation in the vertical, pitch, and roll degrees of freedom Each unit design is based on metal springs to minimize damping The antiresonant bar is pivoted independently of the airframe and the transmission by bearings The transmissibility at antiresonance, 4/Rev frequency, is better than 0.01 (99% isolation), transmissibility at 8/Rev was about 0.2, which was well below the design criterion The rationale that led to the IRIS design is given, and an analytical model of the IRIS is presented In flight tests, transmissibility of each isolator during a rotor speed sweep averaged about 0.05 at the normal speed of 286 rpm

P T H

A79-18151 Lag damping in autorotation by a perturbation method F S Wei and D A Peters (Washington University, St Louis, Mo) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings Washington, D C, American Helicopter Society, 1978 13 p 6 refs NSF Grant No ENG 76-84439 (AHS 78-25)

The effects of autorotation on lag damping are studied by a perturbation method Closed-form expressions for the periodic equilibrium of trimmed or untrimmed rotors are derived from harmonic balance formulas and are simplified by neglecting reversed flow and other terms of fourth order in the advance ratio The perturbation procedure provides considerable computational savings over Floquet theory and is uniformly convergent for advance ratios below 0.4 It is shown that the second harmonic coefficients have negligible effect on in-plane damping for advance ratios below 0.4 The autorotation flight condition is considerably less stable than the power flight condition, and instabilities can occur even for soft in-plane rotors

P T H

A79-18152 Handling qualities aspects of the Bell Model 222 design and development program M L Hester, D A Popelka, and D C Maahs (Bell Helicopter Textron, Fort Worth, Tex.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings Washington, D C, American Helicopter Society, 1978 9 p (AHS 78-26)

The subject of this paper is the impact that handling qualities considerations have had on the design and development of Bell Helicopter Textron's Model 222 Light Twin Helicopter. The main handling qualities criteria, both FAA required and company-established, are discussed. Developmental flight test handling qualities problems and their solutions are described. A description is presented of the production configuration, and the static and dynamic stability characteristics provided by this configuration. Additional features are discussed, including increased survivability after a tail rotor loss, water borne stability, and an optional Automatic Flight Control System. (Author)

A79-18153 * # Analytical design of a high performance stability and control augmentation system for a hingeless rotor helicopter K Miyajima (NASA, Ames Research Center, Moffett Field, Calif.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings Washington, D C, American Helicopter Society, 1978 16 p 14 refs (AHS 78-27)

A stability and control augmentation system (SCAS) was designed based on a set of comprehensive performance criteria. Linear optimal control theory was applied to determine appropriate feedback gains for the stability augmentation system (SAS). The helicopter was represented by six degree-of-freedom rigid body equations of motion and constant factors were used as weightings for state and control variables. The ratio of these factors was employed as a parameter for SAS analysis and values of the feedback gains were selected on this basis to satisfy three of the performance criteria for full and partial state feedback systems. A least squares design method was then applied to determine control augmentation system (CAS) cross feed gains to satisfy the remaining seven performance criteria. The SCAS gains were then evaluated by nine degree-of-freedom equations which include flapping motion and conclusions drawn concerning the necessity of including the pitch/regressing and roll/regressing modes in SCAS analyses. (Author)

A79-18154 Simulation of automatic flight control system failures N N Batra, K E Bults (Bell Helicopter Textron, Fort Worth, Tex.), and J M Davis (U S Army, Research and Technology Laboratories, St Louis, Mo.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings Washington, D C, American Helicopter Society, 1978 11 p 7 refs Grants No DAAJ01 75-C-1126, No DAAJ01 76-C-0389 (AHS 78-28)

A piloted simulation program was conducted to establish the effects of a runaway automatic flight control system and to determine the longest time a pilot could delay before initiating corrective action and still maintain control of the aircraft. Simulation was performed on a six degree-of-freedom moving-base simulator. To authenticate the simulator's response with respect to the actual 214 helicopter, an extensive validation test was conducted, comprising open loop tests, qualitative piloted tests, and quantitative piloted tests. The effect of hardover in a single axis is compared with failures in two of the three axes simultaneously. The effect of airspeed was also noted. The simulations confirmed the credibility of a mathematical model for a generalized single rotor helicopter. P T H

A79-18155 * # A piloted simulator investigation of augmentation systems to improve helicopter nap-of-the-earth handling qualities R T N Chen, P D Talbot, R M Gerdes, and D C Dugan (NASA, Ames Research Center, Moffett Field, Calif.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings Washington, D C, American Helicopter Society, 1978 23 p (AHS 78-29)

A piloted simulation study assessed various levels of stability and control augmentation designed to improve the handling qualities of several helicopters in nap-of-the-earth (NOE) flight. Five basic single rotor helicopters - one teetering, two articulated, and two hingeless - which were found to have a variety of major deficiencies in a previous fixed based simulator study were selected as baseline configurations. The stability and control augmentation systems (SCAS) include simple control augmentation systems (CAS) to decouple pitch and yaw responses due to collective input and to quicken the pitch and roll control responses, SCAS of rate command type designed to optimize the sensitivity and damping and to decouple the pitch-roll due to aircraft angular rate, and attitude command type SCAS. Pilot ratings and commentary are presented as well as performance data related to the task. SCAS control usage and their gain levels associated with specific rotor type are also discussed. (Author)

A79-18156 * Rotorcraft system identification techniques for handling qualities and stability and control evaluation W E Hall, Jr, N K Gupta, and R S Hansen (Systems Control, Inc., Palo Alto, Calif.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings Washington, D C, American Helicopter Society, 1978 23 p 24 refs Contract No NAS1 14549 (AHS 78-30)

An integrated approach to rotorcraft system identification is described. This approach consists of sequential application of (1) data filtering to estimate states of the system and sensor errors, (2) model structure estimation to isolate significant model effects, and (3) parameter identification to quantify the coefficient of the model. An input design algorithm is described which can be used to design control inputs which maximize parameter estimation accuracy. Details of each aspect of the rotorcraft identification approach are given. Examples of both simulated and actual flight data processing are given to illustrate each phase of processing. The procedure is shown to provide means of calibrating sensor errors in flight data, quantifying high order state variable models from the flight data, and consequently computing related stability and control design models. (Author)

A79-18157 Handling qualities of Army/Hughes YAH-64 advanced attack helicopter K B Amer, R W Prouty, R P Walton (Hughes Helicopters, Culver City, Calif.), and J E Engle (Sperry Flight Systems, Phoenix, Ariz.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings Washington, D C, American Helicopter Society, 1978 20 p (AHS 78-31)

The YAH 64 Advanced Attack Helicopter satisfies the requirements for good handling qualities in a hostile environment. These qualities include a tailored combination of controllability and stability in all flight regimes from low speed nap of the-earth flight to high speed point-to-point flight. Flight qualities with the stability augmentation system (SAS) off are enhanced by good control power from the offset hinge rotor, by effective empennage surfaces, and by a control system with low friction and good centering characteristics. Further improvements in flying qualities were achieved with a relatively low authority SAS with an effective monitoring system. P T H

A79-18158 Inertia welding of YAH-64 main rotor drive shaft J E Leach, Jr (Hughes Helicopters, Culver City, Calif.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings Washington, D C, American Helicopter Society, 1978 5 p (AHS 78-32)

The paper describes an efficient cost effective method of inertia welding two different types of steel (Nitralloy N and a maraging steel) for the YAH-64 helicopter main rotor shaft. Inertia welding was chosen because a solid-state bond is formed with joint strengths near or equal to the basic strength of the parent material. Inertia welding parameters are summarized and results of fatigue tests on weld specimens are reported. It was found that the drive shaft cross section could be reduced at a cost of \$10.00 per pound of weight saved. P T H

A79-18162 Filament wound main rotor blade The Army's new production blade for the AH-1 M L White (Kaman Aerospace Corp., Bloomfield, Conn.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C., May 15-17, 1978, Proceedings Washington, D C., American Helicopter Society, 1978 10 p 13 refs (AHS 78-36)

A composite main rotor blade, constructed primarily of S glass/epoxy and Kevlar/epoxy, has been developed for the AH-1 helicopter. The design employs wet filament winding and closed die molding as major production processes. Details on design, development testing, and fabrication are reported P T H

A79-18163 The 214 fiberglass blade - Design for inspectability N Phillips and C E Covington (Bell Helicopter Textron, Fort Worth, Tex.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C., May 15-17, 1978, Proceedings Washington, D C., American Helicopter Society, 1978 10 p (AHS 78-37)

Design, materials, and fabrication of the fiberglass blade for the 214 helicopter are described. The spanwise elements of the spar and trailing edge are wound on a polar winding machine. The winding process produces tubes without laps or seams, which gives better burst strength under ballistic impact. Prepreg was used for the structure. Attention is given to the steps in the outer spar assembly, trailing edge strip, lower skin-core manufacture, and final assembly. The manufacturing sequence was established in such a way as to expose the spar to inspection early in the process P T H

A79-18164 Use of helicopter flight simulation for height-velocity test predictions and flight test risk reduction G Benson, R Bumstead, and A J Hutto (Boeing Vertol Co., Philadelphia, Pa.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C., May 15-17, 1978, Proceedings Washington, D C., American Helicopter Society, 1978 17 p (AHS 78-41)

The paper reports on an exploratory effort conducted in conjunction with the height/velocity testing of the YUH-61A helicopter to predict a height/velocity envelope (heights and velocities for safe recovery after engine failure) by flight simulation supported by flight test. Steps in the prediction of the height/velocity envelope are (1) establish criteria with respect to limiting conditions such as control input delay and rotor speed decay, (2) perform unpowered simulation runs to develop an ideal flight path, (3) perform piloted simulation to obtain pilot reaction and suggested changes to proposed maneuvers, and (4) calculate the height/velocity envelope on the basis of the data gathered in the first three steps. Predicted and test time envelopes were in good agreement P T H

A79-18165 * An innovative technique for static and dynamic V/STOL testing E L Lewis (U S Navy, Naval Air Systems Command, Washington, D C.), R G Culpepper (NASA, Langley Research Center, Hampton, Va.), and V R Hancock (Rockwell International Corp., Columbus Aircraft Div., Columbus, Ohio) In American Helicopter Society, Annual National Forum, 34th, Washington, D C., May 15-17, 1978, Proceedings Washington, D C., American Helicopter Society, 1978 6 p (AHS 78-42)

Initial hover testing of the Navy's XFV-12A V/STOL technology prototype aircraft is being conducted in the former Lunar Lander Research Facility at the NASA Langley Research Center. The aircraft incorporates a unique lift/control concept for V/STOL flight. A key element in the development of this aircraft has been the application of existing hardware and facilities to conserve program funds. Adaptation of the NASA Gantry has created a V/STOL aircraft test facility with unique capability and flexibility. Static lift and control measurements can be obtained and dynamic hover flight can be conducted over a wide range of realistic test conditions (Author)

A79-18166 Testing of the TOW missile-configured AH-1T helicopter D G Cash (U S Navy, Naval Air Test Center, Patuxent River, Md.) In American Helicopter Society, Annual National

Forum, 34th, Washington, D C., May 15-17, 1978, Proceedings Washington, D C., American Helicopter Society, 1978 6 p (AHS 78-43)

The paper reports on the test program for the TOW (tube-launched optically-tracked wire-guided) missile for the AH-1T helicopter. This system includes a stabilized, optically magnified, and motion-compensated periscope sight with associated electronics. Testing included firing 26 TOW missiles. Testing also covered the helmet sight subsystem, jettison-stores separation, and the 20-mm flexible turret. The tests demonstrated the potential of the TOW-missile-configured AH-1T to accomplish close-in fire support and antiarmor/heavy point target attack tasks. An early definition of possible fleet problems was obtained P T H

A79-18167 Generalizing helicopter flight test performance data /GENFLT/ B H Boirun (U S Army, Aviation Engineering Flight Activity, Edwards AFB, Calif.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C., May 15-17, 1978, Proceedings Washington, D C., American Helicopter Society, 1978 13 p 8 refs (AHS 78-44)

This paper discusses a comprehensive method for generalizing helicopter performance using data obtained from the primary types of performance tests (hover, level flight, climb, and descent). This method relates each type of performance data as the base line for low-speed level flight and vertical climb, and the level flight data as the base line for forward flight climb and descent. Momentum theory is used to derive generalized parameters for the power coefficient and velocity ratios, which in many instances eliminates the thrust coefficient as an independent test variable. This method results in a significant reduction in the number of flight test conditions needed for performance definition and illustrates where the test effort should be concerned. The test method allows independent identification of blade stall and compressibility effects as well as calculation of power required for any steady flight condition. The method is illustrated by use of several data sets which include level flight and climb comparisons of the AH-1R equipped with the standard Bell B 540 blades and the Kaman K-747 improved main rotor blades. The OH-58 data are used to illustrate the use of generalized performance in vertical climb (Author)

A79-18168 Electronic control for helicopter engines D A Caine (Lucas Aerospace, Ltd., Solihull, Warwicks, England) and K J Rumford (Avco Corp., Greenwich, Conn.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C., May 15-17, 1978, Proceedings Washington, D C., American Helicopter Society, 1978 11 p (AHS 78-45)

This paper describes the development of a full authority electronic helicopter engine control. The design was based on the fact that the capability of electronics is increasing rapidly. Consequently the maximum use should be made of electronic computation with the mechanical functions minimized. In order to avoid the traditional requirement for precise fuel metering, the system uses a novel closed loop acceleration mode. The system reduces pilot workload by providing isochronous rotor speed governing and torque management. Fail-safe design has been applied effectively to eliminate hazardous defect modes. Also, complete isolation is provided between the engines in multiple-engine systems such that no one control failure can affect both engines. The reliability of the system is enhanced by utilizing thick and thin film circuits that integrate many devices into a single sealed component. The system has undergone bench certification tests, has been fully engine tested on the Lycoming LTS 101 and will shortly be flight tested (Author)

A79-18169 Damage tolerant design of the YAH-64 drive system A C Edwards and A K Neugebauer (Hughes Helicopters, Culver City, Calif.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C., May 15-17, 1978, Proceedings Washington, D C., American Helicopter Society, 1978 9 p (AHS 78-46)

The ballistic tolerance design goals for the YAH 64 drive system were defined as invulnerability and damage tolerance to the 12.7 mm projectile threat, capability to operate for 30 minutes after incurring ballistic damage, high reliability/maintainability, and minimum bearing fatigue life of 4500 hours. General design principles included fail-safe design using multiple members and attachments with redundancy, dual load path structure, use of ballistic-tolerant materials with high fracture toughness, and separation of rotor drive function from rotor flight loads. To achieve survivability, the nose gearbox design involved fine pitch gears with small diameters, large gear backlash, and use of M-50 steel for all primary bearings. The main transmission system has dual lubrication systems. All the components successfully passed the impact tests. P T H

A79-18170 800 shaft horsepower advanced technology demonstrator engine G A Elliott and R G Furgurson (U S Army, Applied Technology Laboratory, Fort Eustis, Va.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings Washington, D C, American Helicopter Society, 1978 10 p (AHS 78-47)

The broad objectives of the Advanced Technology Demonstrator Engine (ATDE) program are to determine the achievable level of performance of turboshaft engines in the 800-hp category designed for use in the Army environment. Key engine performance and design characteristics established at the start include the following: (1) specific fuel consumption at 480 shaft hp no greater than 0.550 lb/hr-hp, (2) minimum of 600 shaft hp at 4000 ft, 95 F operating conditions, (3) free shaft engine, (4) front drive concentric with engine centerline, (5) integral inlet particle separator, and (6) 220 lb as maximum engine dry weight. The basic design concepts proposed by the two competitors are shown. The scope of analyses with regard to reliability and maintainability, ballistic vulnerability, and engine costs and tradeoffs is discussed. A test schedule is outlined. P T H

A79-18171* Definition and analytical evaluation of a power management system for tilt-rotor aircraft J J Morris and H R Alexander (Boeing Vertol Co., Philadelphia, Pa.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings Washington, D C, American Helicopter Society, 1978 8 p 6 refs. Research supported by the Boeing Vertol Co., Contracts No. NAS2-6505, No. NAS2-6598 (AHS 78-48)

The paper reviews the special design criteria which apply to power management in a tilt-rotor aircraft. These include the need for accurate and fast control of rpm and thrust, while accounting for the dynamic interactions between rotor systems caused by cross-shafting and aircraft lateral/directional response. The power management system is also required to provide acceptable high speed sensitivity to longitudinal turbulence. It is shown that the criteria can best be met using a single governor adjusting the collective pitch by an amount proportional to a combination of the average rpm and the integral of the average rpm of the two rotors. This system is evaluated and compared with other candidate systems in hover and cruise flight. (Author)

A79-18172 Loss-of-lubrication operation of helicopter transmissions W A Hudgins (U S Army, Applied Technology Laboratory, Fort Eustis, Va.) and H A Schuetz (U S Army, Aviation Research and Development Command, St Louis, Mo.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings Washington, D C, American Helicopter Society, 1978 12 p 12 refs (AHS 78-49)

The paper summarizes the results of a series of tests on loss-of-lubrication operation of several gearbox designs. Factors for successful operation without oil are: (1) use of vacuum-melt M 50 bearing material with silver-plated steel separators, (2) use of high hot hardness gear materials, (3) use of higher backlash in gears and greater internal clearance in bearings, and (4) use of a lubricant that remains solid during normal operation but becomes fluid at elevated temperatures. A gearbox with an auxiliary system was able

to operate at least two hours after loss of the primary system. Tests on the OH 58C transmission showed that residual lubrication was a major factor in successful operation without oil flow. Detailed study of the temperature trends in components of the OH-58C transmission during loss-of-lubrication testing were conducted, and correlations with torque increases and life were obtained. P T H

A79-18173 Overstress testing of helicopter transmissions K R Cormier (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings Washington, D C, American Helicopter Society, 1978 6 p (AHS 78-50)

Some of the effects of operation at higher than design loads on helicopter transmission components are discussed. Continuous overload of a bearing can result in life reduction beyond that calculated with the basic life equation alone. A component which is designed to pass an accelerated test may incur a weight penalty. When an accelerated test is specified as a qualification test, clear definitions of what are considered disqualifying failures should be given. P T H

A79-18174 Investigation of the crash impact characteristics of composite airframe structures J D Cronkhite, T J Haas (Bell Helicopter Textron, Fort Worth, Tex.), R Winter, R R Cairo (Grumman Aerospace Corp., Bethpage, N Y.), and G T Singley, III (U S Army, Aviation Research and Development Command, St Louis, Mo.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings Washington, D C, American Helicopter Society, 1978 16 p 40 refs (AHS 78-51)

The paper reports on an investigation of the crash impact characteristics of advanced troop transport helicopter airframe structures constructed of composite materials. Currently available information was surveyed on the crash impact behavior of composite materials, analytical tools for design of crashworthy airframe structures, and airframe structure crashworthiness design criteria. Information on the crash impact behavior of composite materials was found to be limited. An automotive study showed that by innovative design, composite materials could function efficiently as energy absorbers to reduce crash impact loads. Effects of composite materials on the compliance of airframe structures with current Army crashworthiness requirements are discussed. (Author)

A79-18175 Spacewound composite structures D E Good (U S Army, Applied Technology Laboratory, Fort Eustis, Va.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings Washington, D C, American Helicopter Society, 1978 10 p (AHS 78-52)

The spacewound structural concept is an open weave, wet filament wound composite structure that has potential for rapidly venting overpressure due to projectile blast and for providing redundant load paths. Several configurations with various materials (Kevlar-49, S-2 fiberglass, and Thornel graphite 300 fibers) and fiber coverage ratios of 25% and 50% were initially tested to evaluate their relative ballistic tolerance to a high explosive projectile. The effect of a skin cover was also evaluated. Except for the graphite specimen, the pressure-vessel type failure mode experienced by conventional metal and composite sandwich structures did not occur. The covering had the effect of additional pressure containment. The Kevlar construction was selected for final design evaluation. A specimen with 50% fiber coverage ratio appeared to be the superior structure. P T H

A79-18176 Composite wing technology on the AV-8B advanced aircraft B L Riley (McDonnell Aircraft Co., St Louis, Mo.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C, May 15-17, 1978, Proceedings Washington, D C, American Helicopter Society, 1978 11 p (AHS 78-53)

The Naval Air Systems Command (NAVAIR) anticipates that graphite/epoxy composite material will be the primary material in the wing of production aircraft for the AV-8B Advanced V/STOL aircraft. The AV-8B wing torque box utilizes composite one piece fullspan upper and lower monolithic skins. The substructure will incorporate composite sine wave spars and ribs. The flap, flap door, aileron, outrigger fairing, overwing fairing, and engine bay doors are also of composite construction. This paper describes the composite wing design, weight savings, development test program, design criteria, and the full scale certification program leading to the use of composites for production aircraft. Some of the structural design problems, tradeoffs, and load/strain criteria are described. The significance of scheduling, typical procedures governing the development of design data, and the interpretation and evaluation of full scale test results are explained. (Author)

A79-18177 The application of composites to secondary structures. L. J. Marchinski and C. A. Greco (Boeing Vertol Co., Philadelphia, Pa.) In American Helicopter Society, Annual National Forum, 34th, Washington, D.C., May 15-17, 1978, Proceedings. Washington, D.C., American Helicopter Society, 1978 13 p (AHS 78-55)

A comparative study of designs for advanced composite cargo floors is described. The floors are designed for a uniform unit cargo loading of 300 lbs/sq ft for the YUH 61A, CH-46, and CH-47 helicopters. Designs for the CH-47 included chemical-milled aluminum extrusions for all floor panels, aluminum sheet and aluminum longitudinal hat sections bonded together as replacement for all floor panels, and NOMEX honeycomb with unidirectional E glass top skin and fiberglass bottom skin for all floor panels. Impact tests and panel bending tests were conducted. P. T. H.

A79-18178 Structural Integrity Recording System for helicopters. D. M. Saylor (U.S. Army, Applied Technology Laboratory, Fort Eustis, Va.) In American Helicopter Society, Annual National Forum, 34th, Washington, D.C., May 15-17, 1978, Proceedings. Washington, D.C., American Helicopter Society, 1978 10 p (AHS 78-57)

The Structural Integrity Recording System (SIRS) will permit determination of the usage spectrum of an individual helicopter for calculation of the fatigue lives of helicopter dynamic components. The SIRS includes a microprocessor based recorder, a portable flight-line retrieval unit (RU), and a fatigue damage assessment system (FDAS) software package. The recorder monitors pitot pressure, static pressure, outside air temperature, transmission lift link strain, aircraft pitch angle, roll angle, engine torque pressure, main rotor rotational speed, and vertical acceleration at CG. Qualification testing of the system is described. P. T. H.

A79-18179 Digital simulation of the Operational Loads Survey flight tests. J. R. Van Gaasbeek (Bell Helicopter Textron, Fort Worth, Tex.) and E. E. Austin (U.S. Army, Applied Technology Laboratory, Fort Eustis, Va.) In American Helicopter Society, Annual National Forum, 34th, Washington, D.C., May 15-17, 1978, Proceedings. Washington, D.C., American Helicopter Society, 1978 12 p 11 refs (AHS 78-58)

The Operational Loads Survey, a comprehensive flight test program, was conducted on an extensively instrumented AH-1G helicopter. The test program was designed to record rotor aerodynamic environment and rotor, control system, and airframe response and loads over the operational spectrum of the aircraft. The current study was initiated shortly after completion of the test program with the goal of validating the Rotorcraft Flight Simulation Program C81 by simulating several test points from the Operational Loads Survey and comparing the computed and experimental data. This paper discusses the modified aircraft, the test program, and certain aspects of the preparation of the data deck representing the aircraft. Data comparisons are presented for level flight. (Author)

A79-18180 The aeroelastically conformable rotor concept. R. H. Blackwell (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.) and D. J. Merkley (U.S. Army, Applied Tech-

nology Laboratory, Fort Eustis, Va.) In American Helicopter Society, Annual National Forum, 34th, Washington, D.C., May 15-17, 1978, Proceedings. Washington, D.C., American Helicopter Society, 1978 18 p 13 refs (AHS 78-59)

An analytic investigation was conducted to determine the feasibility of improving helicopter performance and reducing flight loads by passive control of blade torsional response. Distributions of time-varying blade elastic twist that improve performance and decrease blade stress are identified. Blade design features producing the desired twisting are then sought through examination of model and full-scale torsional response data and through an analytic evaluation of significant parameters. Results indicate a significant potential for inducing 1P and 2P elastic twisting. Tip sweep on a blade of reduced torsional stiffness improves performance and reduces control loads and blade stress by inducing a 1P torsional response which decreases advancing-blade twist and increases retreating-blade twist. The dynamic twist produced by negative airfoil camber is shown to reduce blade stress but generally degrade performance. Control of the spanwise distribution of aerodynamic center-center-of-gravity axis offset is shown to be effective in producing 2P elastic twist, which improves forward-flight performance. The potential for improving hover performance by inducing large negative elastic twist is also demonstrated. (Author)

A79-18181 * # Wind-tunnel test results of a full scale multicyclic controllable twist rotor. J. L. McCloud, III (NASA, Ames Research Center, Moffett Field, Calif.) and A. L. Weisbrich (Kaman Aerospace Corp., Bloomfield, Conn.) In American Helicopter Society, Annual National Forum, 34th, Washington, D.C., May 15-17, 1978, Proceedings. Washington, D.C., American Helicopter Society, 1978 20 p 5 refs (AHS 78-60)

Results of wind tunnel testing of a multicyclic controllable twist rotor at several flight conditions and advance ratios of 0.22 and 0.33 are evaluated. It is found that blade flatwise bending moments and root control actuator loads (fixed system) can be reduced with multicyclic control. Flatwise bending moment reductions of 22-30% with concurrent 83% reductions in control loads were predicted. Analysis of profile power changes indicates a decrease in profile power coefficient of 0.00016, corresponding to a loss of 0.12 sq m of equivalent drag area. P. T. H.

A79-18182 # Experimental effects of tip shape on rotor control loads. J. P. Rabbott, Jr. (U.S. Army, Aeromechanics Laboratory, Moffett Field, Calif.) and C. F. Niebanck (United Technologies Corp., Stratford, Conn.) In American Helicopter Society, Annual National Forum, 34th, Washington, D.C., May 15-17, 1978, Proceedings. Washington, D.C., American Helicopter Society, 1978 10 p 5 refs (AHS 78-61)

Experimental results from tests of a 44 ft diam helicopter rotor in the Ames 40- by 80-Foot Wind Tunnel are presented. The rotor system employed four interchangeable blade tips of 5% radius with rectangular, tapered, swept, and swept-tapered planforms. The effects of blade planform geometry are compared primarily on the basis of one-half peak-to-peak control loads for a range of rotor lifts at advance ratios of 0.2, 0.3, and 0.38. However, at the higher advance ratio, the presence of substantial high-frequency harmonic loading is noted and found to be significantly influenced by blade tip planform. This should be considered in evaluating the relative merits of the various tips. The swept-tapered tip lowers control load for the high advancing tip Mach number condition. (Author)

A79-18183 Theoretical prediction of dynamic stall on oscillating airfoils. B. M. Rao, B. Maskew, and F. A. Dvorak (Analytical Methods, Inc., Bellevue, Wash.) In American Helicopter Society, Annual National Forum, 34th, Washington, D.C., May 15-17, 1978, Proceedings. Washington, D.C., American Helicopter Society, 1978 10 p 18 refs Grant No. DAAG29-76-C-0019 (AHS 78-62)

A quasi-steady flow analysis is developed for predicting the dynamic stall of a two-dimensional airfoil undergoing a pitching harmonic motion. The flow field is solved at several angles-of-attack during a complete cycle. A potential flow program, using a

separation wake obtained from a steady viscous/potential flow program is adopted. The wake model and the separation region do not include the effects of the dynamic motion of the wake and the laminar bubble bursting process. Results obtained on a NACA 0012 undergoing a sinusoidal motion at a Reynolds number 6,000,000 indicate the expected trends of the hysteresis loops for C sub I versus alpha and C sub m versus alpha (Author)

A79-18184 **Onset of leading edge separation effects under dynamic conditions and low Mach number** T S Beddoes (Westland Helicopters, Ltd., Yeovil, Somerset, England) In American Helicopter Society, Annual National Forum, 34th, Washington, D C., May 15-17, 1978, Proceedings Washington, D C., American Helicopter Society, 1978 13 p 14 refs Research supported by the Ministry of Defence (Procurement Executive) (AHS 78-63)

A global model of dynamic stall of a rotor airfoil is developed that can be used to predict the onset of flow separation and vortex shedding. First, the chordwise distribution of pressure as a function of time is analyzed. A leading edge separation criterion, based on the criterion of Evans and Mort (1959) is then applied. The analysis is valid up to Mach number 0.3. It is possible to simplify the calculation of airfoil peak velocity by linearizing the potential solution and including pitch rate and compressibility terms. The leading edge separation criterion reduces the discrepancies previously observed in establishing a constant time delay between the occurrence of the critical parameter and the initiation of vortex shedding from the leading edge. P T H

A79 18185 * # **Flap-lag-torsion aeroelastic stability of circulation-controlled rotors in hover** I Chopra (NASA, Ames Research Center, Moffett Field, Calif.) and W Johnson (U.S. Army, Aeromechanics Laboratory, Moffett Field, Calif.) In American Helicopter Society, Annual National Forum, 34th, Washington, D C., May 15-17, 1978, Proceedings Washington, D C., American Helicopter Society, 1978 15 p 5 refs (AHS 78 64)

The results of a theoretical investigation of the flap-lag-torsion stability of circulation controlled rotors in hover are presented. Stability boundaries are presented as a function of thrust and lag frequency, at several levels of blowing coefficient, for flap frequencies of 1 1/rev and 1 8/ rev. The effects of several parameters on the blade flap-lag stability are examined, including structural damping, structural coupling, pitch-lag and pitch-flap coupling, and the blade feathering motion. The trailing edge blowing can have a major impact on the blade aeroelastic stability, which should be considered in the rotor design. The implications of these results for the current CCR and X-Wing rotorcraft designs are considered. (Author)

A79-18200 # **Combined-excitation ac generators for aviation (Aviatsionnyye generatory peremennogo toka kombinirovannogo voz-buzhdeniya)** V A Balagurov and F F Galteev Moscow, Izdatel'stvo Mashinostroenie, 1977 95 p 23 refs In Russian

The book lays down principles in the theory and optimal design of combined-excitation ac generators, i.e., generators in which the working magnetic flux is produced jointly by both a permanent magnet and an excitation coil magnet. The design methods are based on analysis of diagrams of the disposition of the magnetic conductances and magnet operating diagrams. Theory and analysis of transient processes are based on the method of two reactions and representation of the permanent magnet in the form of a quick response element. P T H

A79-18229 **ATC simulations for the implementation of bilingual IFR control in Canada** P Stager (York University, Toronto, Canada) In Human Factors Society, Annual Meeting, 22nd, Detroit, Mich., October 16-19, 1978, Proceedings Santa Monica, Calif., Human Factors Society, Inc., 1978, p 513-516

Enroute and Terminal Control Area simulation exercises involving certified bilingual controllers from Montreal Center have

been conducted in order to develop procedures for the implementation of bilingual IFR control in the Province of Quebec. The enroute phase of the program was designed to determine the effect of bilingual control on controller performance and the supplementary procedures required in both a radar and non-radar environment. The effects of traffic load, language, and type of sector on communication characteristics, controller errors, and control effectiveness were also observed. In the terminal control phase the effect of varying work load as a function of the runway-in-use was also included in the analysis of arrival and departure control. Aircraft simulators integrated within the simulations, initially by voice-link and later by data link, enabled representative pilots from professional aviation associations to evaluate the simulation exercises and the proposed bilingual system. Independent exercises investigated bilingual control procedures in situations of an exceptional nature in the terminal and enroute sectors. (Author)

A79-18297 # **The Yak 18T aircraft. Construction and operation (Samolet Iak-18T. Konstruktsiya i ekspluatatsiya)** V L Prishkol'nik and Iu I Iankevich Moscow, Izdatel'stvo Transport, 1978 224 p In Russian

Design layouts of the principal parts and assemblies of the Yak-18T trainer aircraft are shown and discussed. This aircraft is a single-engine monoplane with low wing, single fin tail assembly of semicantilevered braced type, and three point retractable landing gear with nosewheel. The main flight and technical characteristics are given, and instructions on the use of the aircraft and maintenance of the systems are proposed. P T H

A79-18298 # **Automation of blade design for aircraft turbomachines (Avtomatizatsiya konstruirovaniya lopatok aviatsionnykh turbomashin)** B M Aronov Moscow, Izdatel'stvo Mashinostroenie, 1978 168 p 62 refs In Russian

Some aspects of the various design stages of aircraft compressor and gas turbine blades are discussed, with particular reference to analytical methods of designing blade elements and optimizing the blade parameters. Attention is given to the development of mathematical models of complex blade element designs. Experience with computer graphics displays is examined with a view toward generalizing it. Some engineering and economic aspects of the application of computers to the design of aircraft gas-turbine blades are discussed. V P

A79-18302 * **Ignition characteristics of some aircraft interior fabrics** C J Hilado and D L Brandt (San Francisco, University, San Francisco, Calif.) *Journal of Fire and Flammability*, vol 9, Oct 1978, p 527-534 5 refs Grant No. NSG-2039

Six samples of aircraft interior fabrics were evaluated with regard to resistance to ignition by radiant heat. Five samples were aircraft seat upholstery fabrics and one sample was an aircraft curtain fabric. The aircraft seat fabrics were 100% wool (2 samples), 83% wool/17% nylon, 49% wool/51% polyvinyl chloride, and 100% rayon. The aircraft curtain fabric was 92% modacrylic/8% polyester. The five samples of aircraft seat upholstery fabrics were also evaluated with regard to resistance to ignition by a smoldering cigarette. The four samples of wool containing aircraft seat fabrics appeared to be superior to the sample of rayon seat fabric in resistance to ignition, both by radiant heat and by a smoldering cigarette. (Author)

A79-18379 **Effect of absorber parameters on the acoustic characteristics of a cylindrical combustion chamber** V M Sil'verstov (*Fizika Goreniya i Vzryva*, vol 14, Mar-Apr 1978, p 94-101) *Combustion, Explosion, and Shock Waves*, vol 14, no 2, Sept 1978, p 211-217 6 refs Translation

The paper presents a theoretical investigation of the effect of the parameters of a porous sound absorber on the frequency, logarithmic decrement, and sound field of the lower modes of tangential longitudinal vibration in a cylindrical chamber, nonuniformly filled with hot gas. It is shown that the greatest value of logarithmic decrement is attained when the absorber is located in the

large-amplitude region of vibrational pressure. The absorption coefficient turns out to be an index of the efficiency of the absorber only at low values of the imaginary part of the acoustic impedance. B J

A79-18385 Method of calculating the longitudinal, lateral, and crossed aerodynamic derivatives of an aircraft at subsonic velocities. F I Ganiev (*Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Mar-Apr 1978, p. 77-88) *Fluid Dynamics*, vol. 13, no. 2, Nov 1978, p. 221-231. 12 refs. Translation.

The numerous contradictory requirements arising in the designing of modern aircraft necessitate the development of computer-aided methods for extensive parametric studies. In the present paper an engineering method is proposed for calculating the pitch, roll, and yaw derivatives and the induced drag, with allowance for the thickness of the lifting surfaces, the nacelles, and similar elements, for a subsonic aircraft performing low-frequency harmonic vibrations. Results obtained by the method are illustrated and discussed. V P

A79-18396 Effect of slip on the aerodynamic characteristics of a wing at hypersonic speed. V N Golubkin (*Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Mar-Apr 1978, p. 192-195) *Fluid Dynamics*, vol. 13, no. 2, Nov 1978, p. 324-327. 13 refs. Translation.

The behavior of a slender delta wing situated at a finite angle of attack in hypersonic attached flow is analyzed as function of the angle of sideslip. Asymptotic formulas for a wing with hypersonic leading edges are derived on the basis of a modification of Hayes and Probstein's (1966) hypersonic flow theory. The principal terms are obtained of an expansion (in a small parameter representing the density at the shock wave) for the rolling moment coefficient and its derivative with respect to the angle of sideslip. V P

A79-18398 Flow of ideal gas in tapering nozzles. R K Tagirov (*Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Mar-Apr 1978, p. 198-202) *Fluid Dynamics*, vol. 13, no. 2, Nov 1978, p. 331-335. 7 refs. Translation.

The Godunov difference scheme to the first order of precision is used to study the flow of an ideal gas in converging nozzles of arbitrary form. The calculated precision of the local and integral characteristics can be improved by a procedure which involves separation of flow regions, subdivision of a network, and linear extrapolation of calculated data. As an example, the changes in the basic characteristics of the converging nozzles are calculated for the case of jet outflow into an immersed space. M L

A79-18424 Computer aided design at Israel Aircraft Industries. B Dror (Israel Aircraft Industries, Ltd., Engineering Div., Lod, Israel) *Computers and Graphics*, vol. 3, no. 2-3, 1978, p. 93-105. 38 refs.

A synopsis of computer aided design (CAD) technology presently being developed and applied at Israel Aircraft Industries is presented. The iterative aeronautical design process from concept through detail design is studied, and the impact of CAD technology on it is discussed. A technical overview of CAD software systems already developed and employed at IAI is presented, and initial experiences are analyzed. IAI views application of CAD technology to engineering design, analysis and manufacture as a necessary modern tool which can produce substantial savings in flight-vehicle design cycle time and cost while increasing product quality. (Author)

A79-18467 The design and testing of a vertical-axis wind turbine using sails. B G Newman (McGill University, Montreal, Canada) and T M Ngabo *Energy Conversion*, vol. 18, no. 3, 1978, p. 141-154. 13 refs. National Research Council of Canada Grant No. A-7096.

A vertical axis wind turbine using sails rather than solid blades has been designed and tested at large model scale in a 15 ft diameter wind tunnel. The turbine has a relatively high solidity, three blades and an operating range of tip speed ratios from zero to about 2.5.

Two types of sail have been tested - a double sail consisting of two layers of cloth wrapped round a circular leading edge dowel, and a jib sail consisting of a single layer of cloth with the leading edge held by a taut wire. The measured power outputs are about half those of a turbine with solid aerofoil blades running at tip speed ratios of 5 or 6. However, the cost and skill required for manufacture of the sail turbines are less and it is concluded that the present designs, which can be self starting if the trailing edge tension is appropriately set, may have application for 1 kW machines in developing countries. (Author)

A79-18517 Use of the Omega Navigation System in the North Atlantic in the framework of the Navigation Minimum Performance Specifications /NMPS/. (Utilisation du Système de Navigation Oméga /ONS/ sur l'Atlantique nord dans le cadre des NMPS.) N D Adom (Air Afrique, Abidjan, Ivory Coast) *Navigation* (Paris), vol. 26, Apr 1978, p. 182-190. In French.

The Omega and Inertial navigation systems are compared, and their ability to fulfill the Navigation Minimum Performance Specifications (NMPS) is considered. A system selected by one airline uses two Omega systems and one Doppler with a computer. The evaluation of the Equinox and the ONS VII versions of the Omega Navigation System is discussed. Some problems involved in the actual functioning of the navigation and ground-station system are indicated. M L

A79-18521 Rule of fuel management (Règle de gestion carburant). R Cathodeau (Compagnie Nationale Air France, Paris, France) *Navigation* (Paris), vol. 26, July 1978, p. 323-330. In French.

A procedure for calculating flight fuel requirements and optimizing fuel use is described. A slide rule-type device is used to correlate air distance and fuel use patterns. Nomograph representations of the calculations are presented. The changing weight of the unconsumed fuel is taken into account. Examples of the use of the procedure are reported. M L

A79-18534 # Aeroacoustic characterization of free jets (Caractérisation aéroacoustique de jets libres). G Elias, J Maulard (ONERA, Châtillon-sous-Bagneux, Hauts de Seine, France), M Perulli (ONERA, Division Acoustique, Châtillon-sous-Bagneux, Hauts-de-Seine, Compiègne, Université de Technologie, Compiègne, France), and A Lelarge *La Recherche Aérospatiale*, Sept-Oct 1978, p. 251-261. 26 refs. In French.

The paper describes the methods pursued by one research group to characterize sources of aircraft engine noise. The methods used were (1) IR radiometry, which is sensitive to temperature fluctuations, (2) laser schlieren method, giving data proportional to components of the density gradient, (3) Doppler laser anemometry, and (4) fluorescence diffusion measurements to deduce mean and fluctuating concentration. Complex measurements by more than one technique and employing crossed paths were experimented with, in order to reveal the complementary possibilities of the methods. By means of a principle of scale separation and suitable data evaluation methods, reliable statements about noise sources could be obtained. P T H

A79-18550 Finite element analysis of the shear-lag problem. L A McQuillin (Queen Mary College, London, England) *Israel Journal of Technology*, vol. 15, no. 6, 1977, p. 334-339.

The finite-element technique is applied to aircraft structural analysis. For the simple structure examined, analysis requires the load in the bar and also the load gradient. Finite-element analysis of a shear-lag problem is used to determine stress and strain in panels, and the suitability of the procedure is discussed. The boundary values from the technique are considered in some detail, and calculated and experimental shear strains are compared. M L

A79-18551 # Unsteady calculation of vortex sheets emitted by highly inclined lifting surfaces (Calcul instationnaire de nappes tourbillonnaires émises par des surfaces portantes fortement in-

clnées) C Rehbach (ONERA, Châtillon-sous Bagneux, Hauts-de-Seine, France) (NATO, AGARD, Réunion sur l'Aérodynamique des Grandes Incidences, Sandefjord, Norway, Oct 4-6, 1978) ONERA, TP no 1978-83, 1978 10 p 10 refs In French

A method for calculation of unsteady three-dimensional incompressible flows past lifting surfaces at high angle of attack is presented. It is based on application of Lagrange variables to the integrodifferential system consisting of Green's identity and the Helmholtz equation, which is discretized in the form of point vortex singularities. The sudden setting into motion of two simple configurations is treated: a rectangular wing and a flat delta wing, both of aspect ratio 1. Two particular problems are focused upon: the formation of the vortex core and the gradual appearance of sheet instability as it depends on geometry and angle of attack. P T H

A79-18554 # Vortex pattern at the upper surface of a swept wing with a high angle of attack (Système tourbillonnaire présent à l'extrados d'une aile en flèche à grande incidence) J Mirande, V Schmitt, and H Werle (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) (NATO, AGARD, Réunion sur l'Aérodynamique des Grandes Incidences, Sandefjord, Norway, Oct 4-6, 1978) ONERA, TP no 1978-124, 1978 19 p 12 refs In French

Water tunnel and wind tunnel studies of the vortex flow associated with a swept wing at a high angle of attack are reported. The physical pattern of the vortex flow is characterized from its formation near the apex to its breakdown at the trailing edge. A clinometric probe was used to study flow around the wing for a certain configuration. For swept wings with a high angle of attack, flows become detached from the wing but remain organized as stable vortex sheets. M L

A79-18573 Designing airport terminals for transfer passengers R de Neufville (MIT, Cambridge, Mass) and I Rusconi-Clerici (ASCE, Transportation Engineering Journal, vol 104, Nov 1978, p 775-787 9 refs

Many airline passengers use the airport terminal to transit between flights. The problem of how airport terminals should be designed to serve transfer passengers is examined. A procedure is presented for calculating the number of transfers at airports in the United States. Major conclusions for the situation prevailing in the United States are that (1) the procedure presented is suitable for providing the necessary data on total and on-line transfers, (2) a linear relationship exists between the percentage of transfers and that of on-line transfers, these percentages being roughly equal, and (3) pier-finger terminals seem preferable to gate arrival configurations when the rate of total transfers exceeds 30%. S D

A79-18574 * Role of helicopters in airport access J S Dajani (Stanford University, Stanford, Calif) and W J Snyder (NASA, Ames Research Center, Helicopter Systems Office, Moffett Field, Calif) (ASCE, Transportation Engineering Journal, vol 104, Nov 1978, p 799-815 8 refs Grant No. NSG 1121

The paper briefly reviews the role of helicopter systems in the provision of airport access services and evaluates the potential for the future development of such services in major metropolitan areas in the United States. The evaluation is based on a computer simulation of potential helicopter system proposed for 20 metropolitan areas. The simulation provides two indicators that are used to gauge the extent of the feasibility of developing successful systems in these areas: (1) the cost per seat mile, and (2) the break-even number of passengers, expressed as a percentage of total air travelers. It is found that a few metropolitan areas presently have the potential of marginally supporting intra-urban helicopter airport access service. The access systems offer a viable alternative for air passengers placing a high value on their time, and provides the opportunity for better integrating the air transportation service of multiple airports in a given urban region. S D

A79-18635 # Transfer function modeling of air traffic concentration N W Polhemus (North Carolina, University, Chapel Hill, N C) (Institute of Management Sciences and Operations Research

Society of America, Joint National Meeting, New York, N Y, May 1-3, 1978, Paper 23 p 5 refs

The application of linear transfer function models to the analysis of concentration in air traffic control sectors is explored. Using time series recorded simultaneously in three sectors, concentration in the local control sector is related to that in arrival and departure sectors. Model identification problems are noted and suggestions made for future development. (Author)

A79-18638 # The use of analytic tools in the design and development of rotorcraft D R Clark (Analytical Methods, Inc., Bellevue, Wash) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1. Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 1-0 to 1-22 21 refs

Recent developments in the ability to model helicopter configurations using involved potential flow computer codes are reviewed. Advances in complexity from the basic potential flow solution to solutions with full streamline tracing and viscous flow modeling capability are outlined with particular attention being given to the modeling of separated flow in the base region. The use of large, complex computer programs in a development situation is examined and examples are given of how their reliability and responsiveness may be improved through the use of interactive techniques. (Author)

A79-18639 The prediction of supercritical pressure distributions on blade tips of arbitrary shape over a range of advancing blade azimuth angles J Grant (Royal Aircraft Establishment, Farnborough, Hants, England) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1. Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 2-0 to 2-10 12 refs

A numerical method has been developed for calculating lifting three dimensional supercritical flow over a helicopter rotor blade at arbitrary azimuth on the advancing side of a rotor disk by extending transonic small perturbation theory to include spanwise flow terms while neglecting time-dependent terms. Comparisons with experimental results for a nonlifting model rotor fitted with near rectangular and swept tip blades show good agreement over the tip region in the azimuth range 60-120 deg. It is suggested that a progressively sheared tip with a rounded leading edge corner at the extreme tip should be effective in alleviating supercritical conditions around a large portion of the advancing side of a rotor disk. B J

A79-18640 # Application of the local momentum theory to the aerodynamic characteristics of tandem rotor in yawed flight A Azuma, S Saito (Tokyo, University, Tokyo, Japan), K Kawachi (National Aerospace Laboratory, Tokyo, Japan), and T Karasudani (Ministry of Transportation, Tokyo, Japan) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1. Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 4-1 to 4-12 7 refs

Local momentum theory is used to study the aerodynamic interference between two rotors (i.e., tandem rotor) in yawed flight. Since the theory is based on the instantaneous momentum balance with the blade element lift at a local station of the rotor rotational plane, the induced velocity generated by one rotor over another rotor can be easily calculated and thus the aerodynamic efficiency due to the interference between two rotors is simply obtained without laborious computation. Calculations have been performed for the performance of two tandem rotor helicopters, CH 46 and CH-47, in yawed flight and compared with the results obtained by other theories and the flight test data. The comparison has shown good agreement over a wide range of yawing angles in both directions and confirmed that the right yaw between 10-20 degrees brings about 5 percent power reduction in these helicopters. (Author)

A79-18641 # Optimization of jet distribution along the blade for VTOL jet propelled rotor V Fiorini (Roma, Università, Rome, Italy) and E Santoro (Salerno, Università, Salerno, Italy) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1

Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 5-0 to 5-14 5 refs

The paper develops a method for optimizing the distribution of the jet along the outer portion of the blade span of a jet propeller for both hovering flight and forward flight under the assumption of constant aerodynamic efficiency along the blade. Numerical results are presented for a representative three-blade propeller with a diameter of two meters for both hovering and forward flight conditions. A considerable improvement in global figure of merit using this method is indicated. B J

A79-18642 # Rotor prediction with different downwash models R Stricker and W Gradl (Messerschmitt-Bolkow-Blohm GmbH, Munich, West Germany) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1

Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 6-0 to 6-21 25 refs. Research sponsored by the Bundesministerium der Verteidigung

Typical rotor downwash models are compared, including local momentum theory, prescribed wake analysis, and a free wake model. A simple semiempirical model is presented which is based on local momentum theory but promises results, especially for transition flight, similar to those calculated with more elaborate vortex models. Results using these models are presented on rotor blade loads, specific flight dynamics data, rotor vibrations, and acoustic characteristics. B J

A79-18643 # Aerodynamics of wing-slipstream interaction especially for V/STOL configurations B Strater (Darmstadt, Technische Hochschule, Darmstadt, West Germany) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1

Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 7-0 to 7-12 9 refs

A method for calculating the wing loading of propeller wing configurations is presented. The nonuniform velocity field within a slipstream is taken into account as well as displacement effects of an inclined slipstream occurring in the transition flight of a tilt wing V/STOL aircraft. A semiempirical procedure, describing the wing loading allows solutions even in the stalled region. In calculating the aerodynamic characteristics of a propeller-slipstream configuration, the slipstream boundary conditions and the wing tangency flow condition are fulfilled. Some results, showing the influence of the nonuniform slipstream velocity distribution are presented. In addition some predicted results are compared with test results. (Author)

A79-18644 An investigation of the influence of fuselage flow field on rotor loads, and the effects of vehicle configuration P G Wilby, C Young, and J Grant (Royal Aircraft Establishment, Farnborough, Hants, England) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1

Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 8-0 to 8-8 11 refs

A modified panel method is used to evaluate fuselage effects on rotor loads for fuselage shapes representing the Puma and Lynx helicopters. Calculations indicate that fuselage upwash can cause a perturbation to aerodynamic forces leading to significant blade and hub response in a form dependent on rotor blade stiffnesses, even when no blade stall is induced. For the Lynx helicopter the effect is observed as an increase in blade lagwise bending moment and in-plane hub force. Wind tunnel results on a model rotor have shown that the method for predicting fuselage flow effects on rotor loads is reasonably accurate, with perhaps a slight underestimate of the true magnitude. B J

A79-18645 # Green's function method for compressible unsteady potential aerodynamic analysis of rotor-fuselage interaction L Morino (Boston University, Boston, Mass) and P Soohoo (Aerospace Systems, Inc., Burlington, Mass) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1

Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 9-0 to 9-12 63 refs

A general and efficient method for the unsteady compressible potential aerodynamic analysis of helicopter rotor-fuselage configurations in hover and forward flight is presented. The method is based on the Morino integral equation for the exact nonlinear three-dimensional velocity-potential equation for lifting bodies of arbitrary shape, and has been applied in the past to both helicopter and windmill motions. Steady state results are presented and the effects of compressibility are discussed in detail. B J

A79-18646 # 2D simulation of unsteady phenomena on a rotor J Renaud (Société Nationale Industrielle Aérospatiale, Division Hélicoptères, Marignane, Bouches du Rhône, France) and J Coulomb (Toulouse, Centre d'Essais Aeronautiques, Toulouse, France) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1

Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 10-0 to 10-17 51 refs

A procedure for the two-dimensional simulation of unsteady aerodynamic effects on rotor blades is developed for the case of harmonic oscillations in pitch. In addition, the CEAT wind tunnel setup for rotor vibration testing is described. The prediction models developed are based on simple perfect fluid models and synthesis of experimental results. Using these models it has been possible to show the relative influence of the perfect fluid and boundary layers on stall delay. Particular consideration is given to the synthesis of boundary layer separation results. B J

A79-18647 # A new approach to rotor blade stall analysis

T J Hajek and A A Fejer (Illinois Institute of Technology, Chicago, Ill) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1

Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 11-0 to 11-12 8 refs. Grant No DAHCO4-75-G 0142

A 0.3-m-chord NACA 0012 airfoil was subjected to stall analysis in the IIT closed-circuit oscillating flow wind tunnel. Good agreement was found between the performance of the stationary airfoil in steady flow and in oscillating flow for various moments of the cycle. When there is simultaneous oscillation of flow and airfoil, it is found that the flow is no longer quasi-steady. This simultaneous oscillation phenomenon is documented here for the first time. B J

A79-18648 # Unsteady aerodynamics of a circulation controlled airfoil L V Schmidt (U S Naval Postgraduate School, Monterey, Calif)

In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1

Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 12-1 to 12-22 11 refs. Contract No N00019 78 WR 81002

Experiments were conducted in a boundary layer wind tunnel to investigate the unsteady aerodynamics of circulation control airfoils (CCAs) for the case of harmonic blowing perturbations superimposed on a mean cavity pressure. Circulation control was achieved on the elliptical airfoil by tangential jet injection at an upper surface slot just ahead of the rounded trailing edge. Preliminary results were obtained disclosing the nature of unsteady surface pressures (both amplitude and phase) over the airfoil. Consideration was given to Coanda sheet dynamics, airfoil lift transfer function, and airfoil damping moment. B J

A79-18649 # Design and wind tunnel testing of 15 m

diameter model rotors. A Bremond, A Cassier, and J M Pouradier (Société Nationale Industrielle Aérospatiale, Division Hélicoptères,

Marignane, Bouches-du Rhône, France) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta SpA, 1978, p 13-0 to 13-7 6 refs

The paper describes the evolution of a 3 m-diameter circular cross-section wind tunnel for the testing of model rotors with diameters of about 1.5 m in order to investigate quickly and economically the effect of any given parameter on the performance and dynamic behavior of a rotor in hover or forward flight Tip speeds of 190-230 m/sec and tip speed ratios of up to 0.45 were set as objectives in order to comply with the Mach numbers encountered on a rotor and to analyze the effects of compressibility Results of the August 1977 test campaign are presented including the effects of tip speed on performance and the vibration behavior of a rotor in hover and forward flight B J

A79-18650 # Improvements in rotor performance by rotor tip blowing I C Cheeseman and H Taner (Southampton, University, Southampton, England) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta SpA, 1978, p 14-0 to 14-4

The use of a pneumatic tip device to improve rotor performance is discussed and preliminary experimental results using this device are examined It is shown that blowing air normal to the chord of the blade at the tip can produce significant increases in thrust (13-16%) at the same power or 25% reduction in power for the same thrust This result appears to be achieved by increasing the lift on the tip section, with corresponding improvements in the lift distribution inboard This effect is compatible with a tip fence or tip shroud performance B J

A79-18651 # Hot wire measurements of stall and separation on helicopter rotor blades H R Velkoff and R L Ghai (Ohio State University, Columbus, Ohio) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta SpA, 1978, p 15-0 to 15-23 6 refs Army sponsored research

Hot-wire anemometry was used to study the nature of rotor blade stall during hover and simulated forward flight in tests conducted on a rotating model rotor blade installed in a flow channel It was found that separation occurred near the trailing edge for blade pitch angles of 5 deg or more and advance ratios of 0.16 or more The separation gradually moved toward the leading edge at stall onset, and then back again during recovery During trailing edge stall the separation appeared to move across the blade at velocities ranging from 3 to 9% of the theoretical freestream velocity For blade pitch angles of 15 deg and advance ratios greater than 0.16, separation occurred near the leading edge as well as at the trailing edge B J

A79-18652 # Rotor blade lag plane frequency optimisation using visco-elastic damping A H Vincent (Westland Helicopters, Ltd, Yeovil, Somerset, England) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta SpA, 1978, p 16-0 to 16-10

A theoretical study is presented of the effect of using viscoelastic damping materials on the choice of the rotor blade lag frequencies for rotors with lag frequencies below rotor rotational frequency Requirements determining the choice of lag frequency are examined Having determined the optimum choice of lag frequency, the study examines the practicality of achieving the optimum solution, with emphasis on the feasibility of using low damping-high fatigue strength materials A set of design rules enabling the optimum design damper to be achieved is presented B J

A79-18653 * # The role of rotor impedance in the vibration analysis of rotorcraft K H Hohenemser (Washington University, St Louis, Mo) and S-K Yin (Bell Helicopter Textron, Fort Worth, Tex) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta SpA, 1978, p 17-0 to 17-34 14 refs Contract No NAS2-7613

In an improved method which retains the advantage of separate treatment of rotor and airframe, the rotor impedance is used to correct the input to the airframe This improved method is illustrated for a strongly idealized case of vertical excitation and then for rolling and pitching moment excitation of a four bladed hingeless rotor on an up-focussing flexible mount Contrary to the usual approach that represents aeroelastic blade motions by a series of normal blade modes in vacuum, the aeroelastic rotor impedances are computed directly with a finite blade element method that includes aerodynamics The rotor impedance matrix for three or more blades is determined from the root moment impedance for a single blade by a simple multiblade transformation rule Force and moment amplitudes transferred from the rotor to the support are found to be critically dependent on the support dynamics (Author)

A79-18654 * # The RSRA Active Isolation/Rotor Balance System W A Kuczynski and J Madden (United Technologies Corp, Sikorsky Aircraft Div, Stratford, Conn) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta SpA, 1978, p 18-1 to 18-24 5 refs NASA Army-sponsored research

The Rotor Systems Research Aircraft (RSRA) includes provisions for the installation of an Active Transmission Isolation/Rotor Loads Balance System (AIBS) The purpose of this system is to enable aircraft operation with an arbitrary rotor system over a wide rotor speed range and maneuver envelope without vibration envelope restrictions, while simultaneously providing measurement of rotor system loads The present paper reviews the history of the design and development of this system, which culminated in successful flight test evaluation in 1977 Consideration is given to highlights of the design, ground test, and flight test B J

A79-18655 # Finite element dynamic analysis of production aircraft A McLaughlin (Westland Helicopters, Ltd, Yeovil, Somerset, England) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta SpA, 1978, p 20-0 to 20-9 7 refs Research supported by the Ministry of Defence (Procurement Executive)

This paper describes studies to compute the normal modes of vibration and forced response characteristics of production designed helicopters The MSC/NASTRAN finite element system with the superelement technique was used A split data base was used, one for the internal and one for the external grid points of the superelements which constituted the primary reduction or condensation to the residual structure 'Free-free' analyses were performed on reduced models to extract the normal modes of vibration in the frequency range of 0 to 30 Hz Using these modes, the responses at several points on the airframe to sinusoidal forcing input at the main rotor head were calculated Correlation studies were then undertaken to compare the theoretically predicted results with those derived from shake tests performed on the aircraft (Author)

A79-18656 # An experimental study of coupled rotor-body aeromechanical instability of hingeless rotors in hover W G Bousman and D H Hodges (US Army, Aeromechanics Laboratory, Moffett Field, Calif) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta SpA, 1978, p 21-0 to 21-27 16 refs

A 162-m diameter, three-bladed rotor model was tested in hover to examine aeromechanical stability of coupled rotor-body systems. Excellent modal frequency data and good lead-lag regressing mode damping data were obtained over a wide range of rotor speeds. Damping data for the body modes were not satisfactory due to nonlinear damping of the gimbal ball bearings. Simulated vacuum testing was performed with circular cross section blades made of tantalum, which resulted in a Lock number 0.2% of the aerodynamic value. The experimental data were compared with theoretical predictions, and the overall agreement was very good. (Author)

A79-18657 * # On methods for application of harmonic control. E. R. Wood, R. W. Powers (Hughes Helicopters, Culver City, Calif.), and C. E. Hammond (U.S. Army, Research and Technology Laboratories, Hampton, Va.) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1. Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S.p.A., 1978, p. 22.0 to 22.16. 17 refs. Army supported research, Contract No. NAS1 14522.

The paper presents data which confirm the effectiveness of higher harmonic blade pitch control in substantially reducing helicopter rotor vibratory hub loads. The data are the result of recent tests on a 2.7 m model conducted in the Langley Research Center's transonic dynamics wind tunnel. Several predictive analyses developed in support of the NASA program are shown capable of accurately predicting both amplitude and phase of the higher harmonic control input required to nullify a single 4/rev force or moment input. The use of multiple blade feathering inputs in the design of a flightworthy higher harmonic control system is discussed. B. J.

A79-18658 # Effect of structural coupling parameters on the flap-lag forced response of a rotor blade in forward flight using Floquet theory. D. P. Schrage (U.S. Army, Aviation Research and Development Command, St. Louis, Mo.) and D. A. Peters (Washington University, St. Louis, Mo.) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1. Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S.p.A., 1978, p. 23.0 to 23.14. 8 refs.

The UTTAS/AAH programs have provided the impetus for the development of an eigenvalue and modal decoupling method to predict helicopter rotor stability and forced response. Stability and forced response can be obtained from the same analysis, making the method an excellent preliminary design tool. Since only one rotor revolution of numerical integration for an initial condition of unity imposed on each degree of freedom is necessary to define the Floquet transition matrix, the method is efficient and yet retains the periodicity of forward flight equations of motion. Results show that the major rotor coupling parameters can be chosen in a systematic way to achieve stability and low rotor loads. B. J.

A79-18659 * # Application of the finite element method to rotary wing aeroelasticity. P. Friedmann (California, University, Los Angeles, Calif.) and F. Straub. In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1. Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S.p.A., 1978, p. 24.0 to 24.23. 18 refs. Army-supported research, Grant No. NGR-05-007-414.

Recent research in rotary-wing aeroelasticity has indicated that all fundamental problems in this area are inherently nonlinear. The non-linearities in this problem are due to the inclusion of finite slopes, due to moderate deflections, in the structural, inertia and aerodynamic operators associated with this aeroelastic problem. In this paper the equations of motion, which are both time and space dependent, for the aeroelastic problem are first formulated in P.D.E. form. Next the equations are linearized about a suitable equilibrium position. The spatial dependence in these equations is discretized using a local Galerkin method of weighted residuals resulting in a finite element formulation of the aeroelastic problem. As an illustration the method is applied to the coupled flap-lag problem of a helicopter rotor blade in hover. Comparison of the solutions with

previously published solutions establishes the convergence properties of the method. It is concluded that this formulation is a practical tool for solving rotary wing aeroelastic stability or response problems. (Author)

A79-18660 # Analysis of free torsional rotor blade oscillations under special consideration of asymmetric swash-plate support. H. Strehlow and F. Trier (Messerschmitt-Bolkow-Blohm GmbH, Munich, West Germany). In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1. Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S.p.A., 1978, p. 26.0 to 26.28. 14 refs. Research sponsored by the Bundesministerium der Verteidigung.

It is well known that a realistic analytical determination of the free torsional rotor blade oscillations cannot be made without taking into consideration the kinematic coupling effects of the control system. Normally the swash-plate is asymmetrically supported by different control springs. For a multi-bladed rotor these effects lead to equations with periodic coefficients. Application of Floquet theory shows that the free torsional rotor oscillations are no longer harmonic but of a multi-frequency type. This special oscillation results from a frequency modulation process which is typical of systems with timevariant, periodic coefficients. A special kind of torsional resonance was measured during high speed flight testing of the BO 105 helicopter, and is explained by this theory. (Author)

A79-18661 # Free-feathering rotor. V. V. Utgoff (U.S. Naval Academy, Annapolis, Md.). In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1. Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S.p.A., 1978, p. 27.0 to 27.22.

This paper presents preliminary results of an analytic and experimental investigation of a free feathering rotor. The free-feathering rotor differs from a conventional fully articulated rotor in that in the free feathering rotor a flap angle is imposed but the blades are free to rotate about the pitch axis, whereas in the conventional rotor a pitch angle is imposed but the blades are free to flap. Blade pitch in the free feathering rotor depends on a balance of aerodynamic and centrifugal forces, just as the flap angle depends on this balance in a conventional rotor. In general, analysis and tests are in fair agreement. In all operating modes the thrust coefficient and coning angle are essentially linearly related if no part of the blade is stalled. In powered axial flow (vertical climb or rotor prop mode) the thrust coefficient decreases with increasing inflow ratio, but to a far lesser degree than in the case of a fixed pitch propeller. (Author)

A79-18662 # Gust response and its alleviation for a hingeless helicopter rotor in cruising flight. M. Yasue, C. A. Vehlou, and N. D. Ham (MIT, Cambridge, Mass.). In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1. Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S.p.A., 1978, p. 28.0 to 28.39. 22 refs. Navy sponsored research.

The vertical gust response and its alleviation for hingeless helicopter rotor blades in cruising flight is studied theoretically and experimentally. An evaluation is performed of the effectiveness of torsional stiffness variation in conjunction with chordwise center-of-gravity shift in alleviating the blade flapping response to decrease the root bending moment. The theoretical analysis utilizes the equations of motion of hingeless rotor blades exposed to vertical gusts in forward flight for the flapping, lagging, and elastic and rigid pitch degrees of freedom. (Author)

A79-18663 # Helicopter simulation in atmospheric turbulence. H. J. Dahl and A. J. Faulkner (Messerschmitt-Bolkow-Blohm GmbH, Munich, West Germany). In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1. Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S.p.A., 1978, p. 29.0 to 29.18. 8 refs.

This paper reviews the topic of helicopter flight in wind turbulence, a topic of primary importance since it is a leading factor in pilot work load, passenger comfort and structural loadings. Whilst much has been done in the areas of turbulence and vehicle modelling for fixed wing aircraft, this is not always applicable to rotary wing aircraft since different flight regimes and principles (low speed, rotating aerofoil) require specialised models. Part of this paper is devoted to the integration of wind gust models to helicopter simulations, highlighting their limitations and particular helicopter requirements. The options for the helicopter model are discussed, ranging from linearised to individual integrated blade response models, and exemplified with test simulation results, with the inclusion of a pilot model in the closed control loop. Results for a helicopter flying through a 2-dimensional turbulence field are presented, with particular attention to the influence of flapping stiffness. (Author)

A79-18664 # The application of multiplex data transmission standards to medium sized military helicopters J M Broadley (Westland Helicopters, Ltd, Yeovil, Somerset, England) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1. Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 30-0 to 30-12.

The feasibility of using multiplex data transmission for military helicopter communications is examined with respect to such general bus considerations as flexibility/expandability, reliability/integrity, and increased effectiveness. Two multiplex schemes which would satisfy the general data flow requirements of the helicopter communication scheme are examined. ARINC 429 and MIL-STD 1553A. The ARINC 429 scheme was shown to be very attractive because it allowed much of the conventional system simplicity to remain. The MIL-STD 1553A scheme was shown to be capable of coping with the requirements, although it is possibly more powerful than is necessary for this particular communication system. B J

A79-18665 # The prediction of helicopter crew information requirements A Cort (Westland Helicopters, Ltd, Yeovil, Somerset, England) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1. Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 31-0 to 31-4. 10 refs.

The methodology of HECATE (helicopter crew activity assessment technique) is described. This technique may be applied to any complex system for which detailed user scenarios can be prepared. It is possible both to compare entire system configurations and to assess the effects of small design changes. Though the information requirements synthesized by the computer model apply to a hypothetical 'ideal' crewman, by suitable weighting estimates can be made of the effects of fatigue, motivation, training, individual differences, etc. HECATE has considerable promise as a cockpit design tool usable from the earliest stages of design. B J

A79-18666 # Simulation requirements for rotorcraft I C Statler and D L Key (U.S. Army, Aeromechanics Laboratory, Moffett Field, Calif.) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1. Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 32-0 to 32-23. 27 refs.

The paper describes the current status of the Army/NASA program to develop a high-fidelity rotorcraft simulation capability that could be exported by both government and industry in research and development. Particular consideration is given to visual display requirements (FOV, level of detail, resolution, contrast, and luminance, dynamic performance, and collimated vs real imagery), motion (platform) requirements, and the computer requirement. It is expected that the current Army/NASA program will result in a unique capability at the Ames Research Center that will benefit the entire helicopter industry. B J

A79-18667 # Correlation aspects of helicopter flight mechanics and pilot behaviour K H Stenner, H J Pausder, and K Sanders (Deutsche Forschungs und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugmechanik, Braunschweig, West Germany) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1. Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 33-0 to 33-13. 13 refs.

Simulation investigations using a moving base simulator to examine the correlations of helicopter dynamics and pilot behaviour for specified maneuvers are presented. The tracking task simulation design of two helicopter configurations is described. Measured parameters including a subjective pilot rating are related. Obtained results from spectral and statistical analysis demonstrate the interrelationships between task-performance precision, control activity and subjective pilot opinions. Correlation analysis suggests subdivision of pilot rating into a configuration dependent part connected with control activity and a pilot dependent part connected with tracking precision. (Author)

A79-18668 # An operators viewpoint on future rotorcraft R & D criteria R J Van Der Harten (KLM Noordzee Helicopters, Schiphol Airport, Netherlands) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1. Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 35-1 to 35-14. 10 refs.

An attempt is made to identify future civil rotorcraft requirements and to develop certain criteria for present and future helicopter R & D programs. Positive as well as negative factors influencing civil rotorcraft development are reviewed. Emphasis is placed on economic factors, all weather capability, passenger and environmental acceptance, and engine fuel economy and one engine out performance. B J

A79-18669 # Casualty evacuation by helicopter L Vachon (Societe Nationale Industrielle Aerospatiale, Division Helicopteres, Marignane, Bouches du Rhône, France) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1. Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 36-00 to 36-08.

The development of an ambulance helicopter is discussed. In cooperation with medical services, a very modern ambulance installation is being designed for the Dauphin helicopter, which allows in-flight performance of all flight actions required for reanimation and small surgery together with transmission of medical data to the hospital which will receive the patient. A first trial installation was flight tested using traffic accident simulation. It was found necessary to use the ambulance helicopter in an actual evacuation mission in a particularly serious case. The validity of the concept was demonstrated. B J

A79-18670 # Sea behaviour prediction of helicopters through free model tests R A Verbrugge and P Gythiel (Lille I, Université, Villeneuve d'Ascq, Nord, France) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1. Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 37-1 to 37-7.

Sea behavior prediction of helicopters generally requires an experimental rather than analytical approach due to difficulties in modeling such phenomena. The main goals of such prediction are (1) to allow the choice of hull shape in the design process, (2) to specify the loads on the structure during maneuvers, and (3) to give handling instructions and determine safety margins. The present paper describes facilities and methods for the sea behavior prediction of helicopters for various situations and maneuvers. The impacts of different types of experimental methods are described. The studies deal with dynamic and static stability, ditching, towing, and hydroplaning. B J

A79-18671 # U S Army helicopter technology initiatives S C Stevens and R B Lewis, II (U S Army, Aviation Research and Development Command, St Louis, Mo) In European Rotorcraft and Powered Lift Aircraft Forum, 4th Stresa, Italy, September 13-15, 1978, Proceedings Volume 1 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 38-1 to 38 14

An overview of current and future helicopter technology initiatives sponsored by AVRADCOM is presented. Seven fundamental technical areas are considered, including aeronautical science, aircraft weapon systems, avionics, propulsion systems, reliability/availability/maintainability, safety/survivability, and structures technology. Examples of ongoing or about-to-begin efforts in each technical area are presented. Several research aircraft concepts are briefly considered, including the Advancing Blade Concept Aircraft, the Rotor Systems Research Aircraft, and the Tilt Rotor Research Aircraft. B J

A79-18672 # The value of various technology advances for several V/STOL configurations W B Peck and A H Schoen (Boeing Vertol Co, Philadelphia, Pa) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 39-0 to 39-8

The paper attempts to answer the following questions: (1) how will technology advances change the relative rankings of helicopters and V/STOLs in terms of size and cost, (2) what areas of research have the greatest payoff, and (3) can increased development funding hasten the date V/STOLs become operational while reducing the life-cycle cost. The Navy's multimission support aircraft requirement was chosen as the basis of the study, the basis of the parametric model was the UTTAS/LAMPS program. The largest single contributor to future cost reduction of V/STOL aircraft is improvement of reliability and maintainability characteristics. Of the basic research now underway, composite materials technology and engine development will have the greatest benefit for size and cost reduction. B J

A79-18673 # Tilt rotor aircraft and the U S Navy G Unger (U S Naval Air Systems Command, Washington, D C) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 1 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 40-0 to 40-16

Results are presented of a Navy design study of a tilt rotor where performance was maximized under a stiff set of requirements. The feasibility of accomplishing several Navy missions in a common tilt rotor aircraft is examined. The limits of tilt rotor technology are considered, and commonality, shipboard compatibility, and design compromises are discussed. The tilt rotor concept is compared to the Advancing Blade Concept and the lift cruise fan concept. It is concluded that the tilt rotor concept is a feasible solution to Navy requirements. B J

A79-18674 * # Recent progress in rotorcraft and powered-lift research L Roberts (NASA, Ames Research Center, Moffett Field, Calif) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 41-0 to 41-18 9 refs

The paper reviews some of the recent technological developments in the United States in the field of rotorcraft and powered-lift research, with primary emphasis on the compound helicopter and the augmentor thrust approaches to vertical flight. The last several years have seen significant developments in the state of the art through the combined use of wind tunnels, simulators, and research aircraft. The results of several representative studies are discussed to demonstrate the improvements that have been made in several of the important vehicle related parameters. The prospect for further advances is also discussed. B J

A79-18675 # A method for estimating takeoff and landing performance of V/STOL aircraft in shipboard environments D P Gleiter (U S Naval Air Development Center, Warminster, Pa) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 42-0 to 42-10

The paper discusses work underway in support of the Navy V/STOL program, with emphasis on the development of data and methods for estimating piloted aircraft performance in the presence of ship motion, wind turbulence, and propulsion-induced effects. A digital simulation approach on a large moving base simulator is taken to the comprehensive analysis of the takeoff and landing dynamics of an aircraft-ship system. Some results from AV 8A simulation runs are presented. B J

A79 18676 # Composite blade for a 5 m diameter tilt rotor G Beziac (Societe Nationale Industrielle Aerospatiale, Division Helicopteres, Marignane, Bouches du-Rhône, France) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 43-0 to 43-16

The convertible aircraft rotor, 5 meters in diameter is intended to be fitted on a 2560 kg gross weight tilting rotor VTOL aircraft (X910 project). The blade planform, twist and spanwise airfoil distribution are derived from the Hirsch vortex theory of optimum propeller thrust for a given power. This theory provides the spanwise optimum circulation distribution which can be met at two different operating conditions (hover and cruise) by a proper choice of chord and lift coefficient distribution. The blade, mounted on a hingeless hub, in flap and lead lag, is made of composite materials in order to ensure high torsional rigidity and to provide correct flexibility in flap and lead lag in the inboard sections. A new blade shank (dagger type design) is used to compact the blade root attachment. Rotor wind tunnel tests were performed in the Modane S1 tunnel over the complete flight envelope including step-by-step and continuous conversions. Expected efficiencies and figure of merit were obtained after modification of the blade sleeve shape. (Author)

A79-18677 # Status report on advanced development program utilizing circulation control rotor technology K R Reader, D G Kirkpatrick, and R M Williams (U S Naval Material Command, David W Taylor Naval Ship Research and Development Center, Bethesda, Md) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 44-0 to 44-22 19 refs

The current status of circulation control rotor (CCR) aerodynamics research and of two full scale flight demonstrator aircraft development programs employing the CCR concept is reviewed. The first program includes the installation of a conventional speed CCR on an existing H-2D aircraft. The second program consists of the development of a new VTOL aircraft, the stopped rotor X Wing. Both of these programs were scheduled to be tested in the NASA Ames 12 x 24 m wind tunnel in late 1978. Preliminary design and hardware fabrication for both the CCR and the X Wing are described. B J

A79-18678 # XV-15 tilt rotor research aircraft and preliminary design of a larger aircraft for the U S Navy subsonic V/STOL mission R Wernicke (Bell Helicopter Textron, Fort Worth, Tex) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 45-0 to 45-12

The progress of the XV-15 tilt rotor research aircraft program is reviewed with emphasis on design details, performance characteristics, and flight testing. The first military application of a tilt rotor could possibly be a larger version of the XV 15, configured to meet

the mission requirement of the Navy's subsonic V/STOL A preliminary design of such a tilt rotor is discussed B J

A79-18679 # Stoppable and stowable jet-flap rotor concept M Kretz (Giravions Dorand, Suresnes, Hauts de Seine, France) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2

Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A , 1978, p 46 0 to 46-13 10 refs

The two-bladed stoppable and stowable rotor (SSR) concept which uses jet flaps for propulsion and control purposes has been analyzed and partly tested The study (with reference to supersonic strike fighter missions) shows that with current technology the weight penalty incurred by VTOL capability corresponds to a total weight fraction of 7 4%, the volumetric increase being 9 0% Experiments show that the SSR can be stabilized at very high advance ratios, corresponding to rotor working conditions during the stop start process, and can withstand vertical gusts of 30 ft/sec by feedback of flapping angle and its control system The SSR aircraft is characterized by a hover endurance of 1 hour, low ground erosion, and low noise level B J

A79-18680 # Modern engine development test techniques

W J Crawford, III (General Electric Co, Aircraft Engine Group, Lynn, Mass) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13 15, 1978, Proceedings Volume 2 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A , 1978, p 47-1 to 47-7

The shift in aircraft engine test philosophy is discussed by comparing the development of two GE engines the T58 and the T700 The T700 had undergone a four year technology engine demonstrator program before its four year development program began in 1972, when the first production engine was delivered in 1978, a total engine test time of 42,000 hours had been accomplished Consideration is given to modern engine development phases, factory tests, air vehicle fuel control assembly testing, air vehicle manufacturer tests, corrective actions, and the costs of not testing B J

A79-18681 # Technology evolution in the Allison Model

250 engine E C Stevens (General Motors Corp, Detroit Diesel Allison Div, Indianapolis, Ind) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A , 1978, p 48-1 to 48-20

The evolution of compressor and turbine technology in the Allison Model 250 gas turbine engine can be largely attributed to the successful application of finite element analysis techniques The technology advances in the combustor resulted from the addition of a smaller-diameter prechamber upstream of the main chamber The combined effects of the component technology improvements on the advanced Model 250 engines are increased power, increased reliability, and improvements in both engine power to-weight ratio and cruise SFC B J

A79-18682 # Engine fuel control systems as a determining factor on modern helicopters H Byasson (Turbomeca S A, Bizaros, Pyrenes-Atlantiques, France) In European Rotorcraft and Powered Lift Aircraft Forum, 4th Stresa, Italy, September 13-15, 1978, Proceedings Volume 2

Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A , 1978, p 49-0 to 49-13

Fuel control system requirements for achieving high-reliability helicopter performance are examined with reference to twin-engine free-turbine helicopters These requirements are considered on the basis of an analysis of all the engine operating phases The design of hydromechanical and electronic fuel control systems is discussed, and consideration is given to the implementation of such controls through analog, digital, and programmable microprocessor techniques B J

A79-18683 # Advancements in design and testing of helicopter drive systems J C Mack (Boeing Vertol Co, Philadelphia, Pa)

In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2

Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A , 1978, p 50 0 to 50 7

The design and development of helicopter drive systems have become systematized Designs are analyzed more rigorously by new analytical approaches, and testing is increasingly a confirmation of predictions rather than an investigation of the unexpected Design and verification begin with initial gear sizing based on conventional stress indices, proceed through detailed resonance, noise, and stress analysis using finite element methods, and conclude with data gathered by means of accelerometers and strain gages The result is that the drive system enters fleet service with an increased assurance of meeting cost, safety, and noise goals to the direct benefit of the user B J

A79-18684 # Ice protection systems of the Puma J Boulet and J C Lecoutre (Societe Nationale Industrielle Aerospatiale, Division Helicopteres, Marignane, Bouches du Rhône, France) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2

Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A , 1978, p 51 0 to 51 8

The paper describes ice protection equipment developed for the Puma helicopter both for light and moderate to heavy icing conditions Emphasis is placed on certification testing for the evaluation of airworthiness under icing conditions B J

A79-18685 Hybrid heater/paste and heater/flexible coating schemes for de-icing helicopter rotor blades J H Sewell

(Royal Aircraft Establishment, Farnborough, Hants, England) and G Osborn (Royal Navy, Naval Aircraft Materials Laboratory, Gosport, England) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13 15, 1978, Proceedings Volume 2 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A , 1978, p 53 0 to 53 7

The paper considers the use of composite flexible substrate coatings for the ice protection (antiicing and ice shedding) of helicopter rotor blades Hybrid systems are described in which a narrow chord heater mat is used for antiicing or deicing of the stagnation region of the blade, aft of this, on both the upper and lower surfaces of the blade, a paste or flexible substrate coating is applied The pastes consist essentially of gelled freezing point depressants (e.g., ethane diol or glycerol) dissolved in a suitable solvent Methods of testing such pastes in icing wind tunnels are described, and consideration is given to an experimental program for the development of optimum composite flexible substrate coatings B J

A79-18686 Helicopter flight-path and acoustic-signal repeatability for noise-diagnosis and noise-certification J Williams and M R P Law (Royal Aircraft Establishment, Aerodynamics Dept, Farnborough, Hants, England) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13 15, 1978, Proceedings Volume 2

Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A , 1978, p 54 0 to 54 12

A flight research programme involving precise measurements of helicopter noise and associated flight paths has been started at RAE, to help satisfy demands for the improvement of noise prediction methods, the reduction of noise with minimum performance penalties, and the definition of realistic noise certification procedures The exploratory experiments now completed have been concerned primarily with the influence of specific operating procedures on helicopter noise characteristics and noise repeatability, mainly during level flight, oblique take-off and oblique landing approach These investigations have involved carefully controlled measurements with kine tracking of repeated flight trajectories over an array of ground-based microphones under quiet test conditions, using Lynx or other helicopters as available Experience from the

planning and execution of this initial programme has already led to the clarification of some new problem areas, the development of better flight-testing techniques for noise diagnosis and noise-certification purposes, and the integration and validation of relevant data analysis software (Author)

A79-18687 # Helicopter noise standards - Another point of view A national approach to rotorcraft noise regulation R R Lynn and C R Cox (Bell Helicopter Textron, Fort Worth, Tex.) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2

Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 55-1 to 55-19 47 refs

Contrasts between subsonic CTOL and rotorcraft regarding operational characteristics, economic base, and state of technology are examined. Noise requirements being considered for helicopters within the United States and the ICAO are reviewed. The economic and safety consequences of these requirements are discussed for new and derivative designs. A noise index is defined and used to compare the relative impact of noise produced by various transportation systems. An alternate approach to noise regulation is suggested that makes use of a maximum noise index and employs flight path and operational controls to achieve it B J

A79-18688 # Design implications of recent gearbox noise and vibration studies F D'Ambra (Société Nationale Industrielle Aérospatiale, Paris, France) and J W Leverton (Westland Helicopters, Ltd, Yeovil, Somerset, England) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2

Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 56-1 to 56-23

The paper reviews experimental work performed to investigate the dominant source of helicopter cabin noise - the main gearbox. Some theoretical considerations relating noise and vibration are reviewed and attention is given to fundamental studies on axisymmetric components, gearbox casings, variation of noise and vibration with operating conditions, the influence of dynamic characteristics on struts, and dynamic modeling. Specific modifications of the SA360 and SA365 main gearboxes are discussed. The development of a design philosophy which incorporates minimum gearbox noise is discussed B J

A79-18689 # Helicopter tail rotor noise generated by aerodynamic interactions A Damougeot (Société Nationale Industrielle Aérospatiale, Division Helicoptères, Marignane, Bouches du-Rhône, France) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2

Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 57-0 to 57-12

The paper describes experimental and theoretical studies of mechanisms of tail rotor noise generated aerodynamic interaction with obstacles (i.e., hub support arms, tail boom, and fin) near the rotor. Two cases are investigated: (1) disturbances of the 'viscous' type for conventional tail rotors where the blades intercept the tail boom and fin wakes, and (2) disturbances of the 'potential' type where the hub support arms downstream of the rotor induce local potential flow distortions in the blade passage area. A model for calculating radiated noise for the 'potential' case is presented B J

A79-18690 # The influence of the transonic flow field on high speed helicopter impulsive noise Y H Yu, F X Caradonna, and F H Schmitz (US Army, Aeromechanics Laboratory, Moffett Field, Calif.) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2

Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 58-0 to 58-16 14 refs

In this paper, the linear model based upon the Ffowcs Williams and Hawkins formulation is studied for the prediction of high-speed helicopter impulsive noise. The model requires detailed knowledge of blade geometry and forces and the flow field surrounding the rotor

near the tip of the blade. For acoustic radiation near the rotor's tip-path plane, the monopole, dipole, and quadrupole sources all contribute - where monopole and quadrupole are equally important contributors to the acoustic far field for the high-subsonic range. Measured peak amplitudes and temporal waveforms show a strong dependence on rotor tip Mach number. A narrow Mach number range is observed, in which the nonlinear transonic near field suddenly delocalizes and extends out for many radii. Below this Mach number, the use of a transonic near-field solution in conjunction with the acoustic analogy results in a noise prediction, which compares well with the experiment (Author)

A79-18691 # Fluctuating surface pressure characteristics on a helicopter fuselage under hover and forward flight conditions K J Schultz and W R Splettstoesser (Deutsche Forschungs- und Versuchsanstalt für Luft und Raumfahrt, Cologne, West Germany) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2

Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 59-0 to 59-12 11 refs

An experimental program was carried out with the objective of determining the role of (1) the direct rotor downwash impingement and (2) the acoustic rotor near-field in the excitation of the fuselage skin and, thus, in the generation of interior noise in the cabin. The experiments were conducted with a full scale helicopter (MBB BO 105C) in flight and by employing the new DFVLR rotor test facility in two large open-jet wind tunnels. The tests emphasized local measurements of the fluctuating pressures on the external cabin surface in the cockpit region at hover and forward flight conditions. Studies on the effects of thrust and forward motion indicate, that the direct rotor downwash impingement influences the fluctuating surface pressure especially at the fundamental blade passage frequency. The effect of forward motion on the A weighted interior noise level is relatively small. However, for flight conditions that produce impulsive noise (blade-slap) a significant influence on the low frequency interior noise is observed (Author)

A79-18692 # Demonstration of potential acoustic gains from conventional cabin soundproofing treatments S Owen, M C A Woodward, and J S Pollard (Westland Helicopters, Ltd, Yeovil, Somerset, England) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2

Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 60-0 to 60-8

Experimental tests were conducted on the Lynx Rotor Rig with the aims of (1) obtaining the maximum attenuation with an inner cabin soundproofing construction and (2) determining noise reduction/weight penalty tradeoff associated with removing parts of the treatment. Consideration is also given to how soundproofing treatments can be further optimized by the use of semiself-supporting materials which can be attached directly to the airframe skin and which incorporate acoustically soft but hard wearing surface trims. Attenuations ranging from 20 dB at 500 Hz to 50 dB at 4 kHz have been demonstrated on the Lynx helicopter using an enclosed inner cabin of Con/Form and foam B J

A79-18693 # Cabin noise reduction for the Agusta A-109 helicopter P Bellavita (Costruzioni Aeronautiche Giovanni Agusta S p A, Gallarate, Italy) and J Smullin (Cambridge Collaborative, Inc., Cambridge, Mass.) In European Rotorcraft and Powered Lift Aircraft Forum, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2

Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 61-0 to 61-29 5 refs

The Agusta A-109 is one of the first mid-1970s helicopters designed to provide high performance for the civil air market. For maximum civil use acceptance, a noise reduction program was initiated to develop interior nonstructural 'carpet hanging' treatments and also to investigate noise sources and transmission paths which might be treated during later development. This paper describes methods of noise control by cabin treatments developed for the Agusta A-109 and presents some preliminary prototype flight test results B J

A79-18694 # Integration of nondestructive testing methods into design for structural integrity assurance F H Immen and W L Andre (U S Army, Research and Technology Laboratories, Moffett Field, Calif) In *European Rotorcraft and Powered Lift Aircraft Forum*, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 62-0 to 62-13 6 refs

The status of NDT procedures involving critical helicopter systems is described, and a procedure for integrating NDT methods into all phases of helicopter design, development, and operational use is outlined. The possibility of integrating the inspection statistics with structural failure probabilities to maintain a consistent structural reliability during the system life cycle is suggested. A fresh approach is presented to selecting, on a cost basis, a safe-life maintenance concept for helicopter systems B J

A79-18695 # Recent advancements in elastomeric products for improving helicopter reliability and maintainability J L Potter (Lord Kinematics, Erie, Pa) In *European Rotorcraft and Powered Lift Aircraft Forum*, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 63-1 to 63-21 5 refs

The development of new elastomeric materials for improved service life, wider operating temperature extremes, and special dynamic properties in such helicopter applications as rotor bearings and lag and landing gear dampers is described. Particular consideration is given to the development of Lastoflex elastomeric thrust bearings for the YUH 60 and UH-60 helicopters. The use of composite materials in combination with elastomers is also discussed. Possible applications of elastomeric materials to the next generation of rotary wing aircraft are briefly discussed B J

A79-18696 # Monitoring of fatigue loading on rotor system and related components D P Chappell (U S Army, Aeromechanics Laboratory, Moffett Field, Calif) In *European Rotorcraft and Powered Lift Aircraft Forum*, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 64-0 to 64-24

This paper gives the results of structural methods research on the subjects of fatigue cycle counting, fatigue damage monitoring, and the effects of spectrum loading on fatigue life. An algorithm is proposed for computer processing of raw data to obtain empirical loading spectra and to estimate fatigue damage. Applications of analytical applied load spectra are illustrated. On the basis of Miner's Rule, along with the analytical applied load spectra, allowable load-cycle curves under spectrum loading are developed for various materials. Correspondence is shown between the method of this paper and an earlier method for estimating fatigue life of helicopter components. Computer programs developed in connection with this research are summarized. The application of these methods to real-time fatigue damage monitoring is discussed (Author)

A79-18697 # Fatigue life estimation methods for helicopter structural parts F Och and M V Tapavicza (Messerschmitt-Bolkow-Blohm GmbH, Ottobrunn, West Germany) In *European Rotorcraft and Powered Lift Aircraft Forum*, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 65-0 to 65-13 7 refs

This paper gives a short survey on life-prediction methods which have been established and proved successful at MBB's helicopter division. Given a load spectrum and a fatigue-strength curve it is possible to use both in connection with a damage accumulation hypothesis to result in an estimation for the component's fatigue-life. An analytical procedure sets up the load-distribution, described statistically by a mean value and a variance for each typical flight condition. Analytical methods are used as well when dealing with the fatigue-strength curve. Given a scatter-band of fatigue-test results it is possible to use a regression analysis to compute the free constants of

an assumed load-cycles to failure formula. With the analytical formulation of both load spectrum and material behaviour in connection with the Miner-Palmgren rule an analytical estimation of the part's life-time is obtained (Author)

A79-18698 # Helicopter behaviour in crash conditions J Mens (Societe Nationale Industrielle Aerospatiale, Division Helicopteres, Marignane, Bouches-du-Rhône, France) In *European Rotorcraft and Powered Lift Aircraft Forum*, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 66-0 to 66-14

A general philosophy for evaluating survival chances in case of helicopter crash is presented, with the general survival problem divided into three phases: (1) definition of initial conditions, (2) definition of structural behavior, and (3) occupant's survival potential. Attention is given to methods for determining the load-distortion characteristics relative to helicopter crash. Using the load-distortion curve of each structural component, the KRASH program can calculate the acceleration loading of all masses involved, especially those of the occupants B J

A79-18699 # Design and checking of helicopter transmission components using photoelastic analysis techniques B Gagnage (Societe Nationale Industrielle Aerospatiale, Division Helicopteres, Marignane, Bouches-du-Rhône, France) In *European Rotorcraft and Powered Lift Aircraft Forum*, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 67-0 to 67-17

The paper describes the application of photoelastic analysis techniques as well as synthetic resin models in the optimization of helicopter structural components. In particular, consideration is given to: (1) the use of photoelastic analysis to check stress levels in components, (2) the use of filled resin models (Modeltech) to optimize transmission components in terms of stress/weight tradeoff, and (3) the use of transparent resin models to measure stresses at any point, accessible or not, using the stress freezing technique B J

A79-18700 # Crack speed and propagation resistance prediction for steels and Al alloys helicopter components V Wagner (Costruzioni Aeronautiche Giovanni Agusta S p A, Gallarate, Associazione Italiana di Metallurgia, Italy), W Hotz, and R Trippodo (Costruzioni Aeronautiche Giovanni Agusta S p A, Gallarate, Italy) In *European Rotorcraft and Powered Lift Aircraft Forum*, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 68-0 to 68-15 25 refs

The evolution of experimental techniques for the prediction of crack growth behavior in steel and aluminum alloy helicopter components is reviewed. Particular consideration is given to Charpy-V test philosophy, and to fundamental fracture mechanics test techniques, including fracture toughness static testing, reduction of area testing, impact tests with fatigue precracked specimens, and the Fissad (super-Schnadt) test. A procedure for predicting crack speeds and crack propagation resistance on the basis of such tests is elaborated B J

A79-18701 # The unsafe zone for single engine helicopters J-M Besse (Societe Nationale Industrielle Aerospatiale, Division Helicopteres, Marignane, Bouches-du-Rhône, France) In *European Rotorcraft and Powered Lift Aircraft Forum*, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2 Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S p A, 1978, p 70-0 to 70-7

The unsafe zone for helicopters is defined by (1) low points for which the vertical speed does not have sufficient time to increase significantly after engine failure, and (2) high points for which, in nose-down attitude, the forward speed which gives the lowest possible vertical speed in self-rotation is reached, making soft landing

possible. These two groups of points meet at a point known as the 'knee'. The present paper studies the effects of various parameters (weight, power, speed, action time delay, maneuver, and altitude) on the 'knee' for a single engine helicopter. Some recommendations concerning the unsafe zone are presented. B J

A79-18702 # Height-velocity diagram determination for twin engine helicopters - Some aspects of present regulations. L. Forzani (Costruzioni Aeronautiche Giovanni Agusta S.p.A., Gallarate, Italy). In *European Rotorcraft and Powered Lift Aircraft Forum*, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2. Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S.p.A., 1978, p. 71-1 to 71-21.

The paper summarizes aspects of H-V diagram (dead man curve) determination for twin-engine helicopters from the test pilot's point of view. The discussion is based primarily on experience with certification testing of Agusta 109 during 1974. The following points are touched on: (1) execution of flight tests in accordance with present regulations, and (2) possible modifications of the present procedure in order to improve flight safety levels during test without compromising test reliability. B J

A79-18703 * # Flight research capabilities of the NASA/Army Rotor Systems Research Aircraft. S. White, Jr. (NASA, Ames Research Center, Moffett Field, Calif.) and G. W. Condon (U.S. Army, Research and Technology Laboratories, Hampton, Va.). In *European Rotorcraft and Powered Lift Aircraft Forum*, 4th, Stresa, Italy, September 13-15, 1978, Proceedings Volume 2. Gallarate, Italy, Costruzioni Aeronautiche Giovanni Agusta S.p.A., 1978, p. 72-0 to 72-27.

After a brief description of the Rotor Systems Research Aircraft (RSRA), the paper reviews their flight capabilities and limitations. A favorable assessment is given to the expected research capabilities of the RSRA. The structural limitations should not significantly constrain the flight envelope for research operations, the handling qualities, though not optimum, are within the parameters originally predicted, and there are no fundamental dynamics problems. Although the accuracy of the force and moment measurement system has not yet been quantified by calibration, it is expected to be acceptable after calibration. B J

A79-18714 Grating lobe control in limited scan arrays. R. J. Mailloux (USAF, Rome Air Development Center, Bedford, Mass.), A. Martinez, III (USAF, Electronics System Div., Bedford, Mass.), L. Zahn, and G. R. Forbes. *IEEE Transactions on Antennas and Propagation*, vol. AP-27, Jan. 1979, p. 79-85. 15 refs.

The use of multiple higher order modes for grating lobe control in arrays of large aperture elements scanned over restricted spatial sectors is described. Arrays of this type are useful in a number of applications including precision approach radar, weapons locators, and satellite communications systems. An extensive experimental and theoretical study that includes the design and use of dielectric lenses for control of E-plane null filling for an eight-element array, the investigation of null width effects on sidelobe levels, the experimental study of an element and control circuitry for two-dimensional scan, bandwidth effects, and the use of dielectric spatial filters and row displacement for residual grating lobe suppression is summarized. (Author)

A79-18834 Hydrodynamic propulsion by large amplitude oscillation of an airfoil with chordwise flexibility. J. Katz and D. Weihs (Technion - Israel Institute of Technology, Haifa, Israel). *Journal of Fluid Mechanics*, vol. 88, Oct. 13, 1978, p. 485-497.

The hydrodynamic forces due to the motion of a flexible foil in a large amplitude curved path in an inviscid incompressible flow are analyzed. A parametric study of large amplitude oscillatory propulsion, with special emphasis on the effect of chordwise flexibility of the fin, is presented. This flexibility was found to increase the propulsive efficiency by up to 20% while causing small decreases in the overall thrust, compared with similar motion with rigid foils. (Author)

A79-18837 The development and structure of turbulent plane jets. K. W. Everitt and A. G. Robins (Imperial College of Science and Technology, London, England). *Journal of Fluid Mechanics*, vol. 88, Oct. 13, 1978, p. 563-583. 17 refs. Research supported by the Science Research Council.

The structure and development of turbulent plane jets in still air and moving streams are described. The nature of the small-scale turbulence cannot be accurately ascertained because of the difficulties inherent in the measurement of dissipation in highly turbulent flows. Although correlation measurements in a jet in still air indicate a large-scale structure which can best be described as 'local flapping', measurements in a jet in a moving stream do not reveal a similar structure. The development of the turbulence structure in a jet in a moving parallel stream is described and the properties of turbulent jets and wakes are shown to be reasonably well predicted by the use of a variable-eddy-viscosity formula together with the formal self-preserving properties of the equations of motion. (Author)

A79-18841 The plane turbulent impinging jet. E. Gutmark, M. Wolfhite (Technion - Israel Institute of Technology, Haifa, Israel), and I. Wygnanski (Tel Aviv University, Tel Aviv, Israel). *Journal of Fluid Mechanics*, vol. 88, Oct. 27, 1978, p. 737-756. 16 refs.

This paper presents an experimental study of the turbulent structure on the centre line of a two-dimensional impinging jet. The mean velocity, turbulent stresses, triple velocity products and temporal derivatives were measured and the energy balances for the three fluctuating components were calculated. The results indicate a selective stretching of vortices in the direction in which the streamlines spread near the wall, causing anisotropy in this region. The distribution of energy among various frequencies was found from spectral measurements. These measurements revealed the existence of a neutral frequency above which the energy was attenuated by viscous dissipation and below which it was augmented by a vortex-stretching mechanism. (Author)

A79-18844 Flow around a circular cylinder near a plane boundary. P. W. Bearman (Imperial College of Science and Technology, London, England) and M. M. Zdravkovich (Salford, University, Salford, Lancs., England). *Journal of Fluid Mechanics*, vol. 89, Nov. 14, 1978, p. 33-47. 9 refs.

The flow around a circular cylinder placed at various heights above a plane boundary has been investigated experimentally. The cylinder spanned the test section of a wind tunnel and was aligned with its axis parallel to a long plate and normal to the free stream. It was placed 36 diameters downstream of the leading edge of the plate and its height above the plate was varied from zero, the cylinder lying on the surface, to 3.5 cylinder diameters. Distributions of mean pressure around the cylinder and along the plate were measured at a Reynolds number of 45,000. Spectral analysis of hot-wire signals demonstrated that regular vortex shedding was suppressed for all gaps less than about 0.3 cylinder diameters. For gaps greater than 0.3 the Strouhal number was found to be remarkably constant and the only influence of the plate on vortex shedding was to make it a more highly tuned process as the gap was reduced. Flow-visualization experiments in a smoke tunnel revealed the wake structure at various gap-to-diameter ratios. (Author)

A79-18845 Mechanism of determination of the shedding frequency of vortices behind a cylinder at low Reynolds numbers. M. Nishioka (Osaka Prefecture University, Sakai, Japan) and H. Sato (Tokyo University, Tokyo, Japan). *Journal of Fluid Mechanics*, vol. 89, Nov. 14, 1978, p. 49-60. 12 refs.

Two kinds of experiment were made in the wake of a cylinder at Reynolds numbers ranging between 20 and 150. One was a close look at the structure of the vortex street with a stationary cylinder at Reynolds numbers greater than 48. The other experiment was made at lower Reynolds numbers with a cylinder vibrating normal to the flow direction. In this case an artificially induced small-amplitude fluctuation grows exponentially with the rate predicted by the stability theory. Because of the similarity between the two kinds of wake,

we postulate that the shedding of the vortex at low Reynolds numbers is initiated by the linear growth, namely, the fluctuation with the frequency of maximum linear growth rate develops into vortex streets. By using the measured width of the wake at the stagnation point in the wake and the result of the stability theory, we could calculate the Strouhal number for Reynolds numbers ranging from 48 to 120. The predicted Strouhal numbers agree well with the values from direct measurements (Author)

A79-19313 # Lift, moment and pressure distribution on cambered airfoil in generalized sinusoidal flow perturbations V Mukhopadhyay (Indian Institute of Technology, Kharagpur, India) *Revue Roumaine des Sciences Techniques, Série de Mécanique Appliquée*, vol 23, Nov-Dec 1978, p 897-903 7 refs

Closed form expressions for lift and moment are obtained, for a general cambered thin airfoil at small angle of attack, under generalized sinusoidal flow perturbations in both transverse and chordwise directions, by applying classical linearized unsteady thin airfoil theory, for incompressible flow. The results agree with the solutions obtained by other authors for specific camber lines (Author)

A79-19358 HCN content of turbine engine exhaust D J Robertson, R H Groth, and A G Glastris (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.) *Air Pollution Control Association, Journal*, vol 29, Jan 1979, p 50, 51

A79-19362 Aircraft noise identification system by correlation technique G Nishinomiya, F Suzuki, and F Sasaki (Japan Broadcasting Corp., Technical Research Laboratories, Tokyo, Japan) *IEEE Transactions on Broadcasting*, vol BC-24, Dec 1978, p 116-120

A Japanese effort at aircraft noise abatement is described. A fully automatic aircraft noise measurement system incorporating the function of identification has been developed. The system discerns the pattern of the cross correlation function between sound signals picked up by two microphones set some distance apart on the ground. The principle of this technique is described and some experimental results are presented B J

A79-19382 # Operation of a multistage axial compressor with nontwisted blades from viewpoint of three-dimensional axisymmetric flow theory (Praca wielostopniowej sprężarki osiowej z niewchrowanymi łopatkami w świetle teorii osiowsymetrycznego przepływu trójwymiarowego) R Pieprzyk *Instytut Maszyn Przepływowych, Prace*, no 74, 1977, p 17-36 12 refs In Polish

The method of Holmquist and Rannie (1956) is modified to calculate the three-dimensional flow of an ideal, inviscid, nonheat-conducting compressible fluid in axial turbomachines. Theoretical results for three-dimensional flow between successive blade rows obtained for 21 operating points under nominal conditions for various rotor speeds and stator blade-angle settings are compared with experimental results. Results are plotted in terms of the power utilization factor (ratio of power actually transferred to fluid to power theoretically transferred on basis of kinematics) as function of rotor speed and stator blade angle P T H

A79-19444 The aerodynamic design of aircraft D Kuchemann Oxford and Elmsford, N Y., Pergamon Press, 1978 573 p 1953 refs \$20

The book presents a complete and detailed theory of aircraft aerodynamic design based on the central question of how do specific desired flight properties lead to specific aerodynamic shapes and configurations. Three basic configurations are studied: the classical aircraft with moderate to high aspect ratio, swept or unswept, the slender aircraft marked by a low aspect ratio wing of delta planform, and the waverider, a sharp-edge lifting body riding on a strong shock wave. There are sections devoted to the fundamental processes of fluid mechanics and the means for generating lift and propulsive force. The bulk of the book is devoted to detailed treatment of the types of flow which relate to the three basic types of aircraft mentioned above P T H

A79-19471 * # Computation of three-dimensional turbulent separated flows at supersonic speeds C C Horstman and C M Hung (NASA, Ames Research Center, Moffett Field, Calif.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting*, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0002 12 p 17 refs

Numerical solutions of the time averaged Navier-Stokes equations employing a simple eddy viscosity model have been obtained for three dimensional turbulent flow fields at supersonic speeds. The computer results are compared with a series of experimental test flows describing the interaction of a swept shock wave with a turbulent boundary layer for various shock-wave strengths. Very good agreement is obtained between the computed and experimental surface and flow-field results. The computed flow fields are examined in detail to investigate the physics of this type of flow field. Questions concerning the existence of a vortex and the relationship between converging surface oil streaks and the resulting flow field are addressed (Author)

A79-19472 * # On the laminar separation, transition, and turbulent reattachment of low Reynolds number flows near the leading edge of airfoils A V Arena and T J Mueller (Notre Dame, University, Notre Dame, Ind.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting*, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0004 12 p 20 refs Grant No. NSG 1419

The laminar separation, transition, and turbulent reattachment near the leading edge of a cylindrical nose constant thickness airfoil model were investigated using a low turbulence, low speed smoke wind tunnel. The locations of separation, transition, and reattachment were obtained from smoke flow photographs and surface oil flow techniques for chord Reynolds numbers from about 150,000 to 470,000. These visual data combined with static pressure distributions and lift and drag measurements delineate the effects of angle of attack, flap deflection angle, and chord Reynolds number on the separation bubble characteristics. The data concerning the length of the laminar and turbulent portions of the bubble agree with the empirical prediction methods for short bubbles (Author)

A79-19477 # Calculation of transonic inlet flowfields using generalized coordinates L T Chen (McDonnell Douglas Research Laboratories, St. Louis, Mo.) and D A Caughey (Cornell University, Ithaca, N Y.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting*, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0012 11 p 14 refs Research supported by the McDonnell Douglas Independent Research and Development Program

A method for calculating inviscid supercritical flowfields about axisymmetric inlet cowls with center bodies is presented. A finite difference approximation to the full potential equation is solved under a general coordinate transformation, using a numerical evaluation of the transformation matrix at each mesh point. For the present problem, a boundary conforming coordinate system was generated by a sequence of conformal and shearing transformations, but this transformation is not essential to the method. Both the quasi-conservative and nonconservative forms of Jameson's rotated differencing scheme are used, and the difference equations are solved by relaxation. Numerical results for pressure distributions generally agree well with experiment (Author)

A79-19495 * # High speed smoke flow visualization for the determination of cascade shock losses J A Slovisky (Notre Dame, University, Notre Dame, Ind.), W B Roberts (Nielsen Engineering and Research, Inc., Mountain View, Calif.), and J E Crouse (NASA, Lewis Research Center, Fan and Compressor Branch, Cleveland, Ohio) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting*, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0042 11 p 17 refs Grant No. NSG 3133

A flow visualization technique has been developed by which quantitative cascade shock loss data can be ascertained without the interference effects of intrusive probes. The technique is first proven feasible by studying the high speed wind tunnel flow around a variety of two dimensional shapes. Applicability is demonstrated by

the testing of a 5% thick sharp-edged flat plate cascade at an upstream Mach number of about 1.3. Results are compared with the relevant theory and total pressure probe data (Author)

A79-19496 # Three-dimensional shock structures for transonic/supersonic compressor rotors D. C. Prince, Jr (General Electric Co., Advanced Engineering and Technology Programs Dept., Cincinnati, Ohio) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0043* 16 p 22 refs

This paper reviews experience at evaluating three-dimensional shock structures for transonic/supersonic compressor rotors, including experimental results obtained by holography, laser velocimetry, and high frequency pressure transducers. Typical shock wave angles are oblique to the relative flow with angles in the range 60-65 deg for maximum deflection rather than the 40-50 deg range predicted by conventional cascade analyses. Results are partially explained by obliquity of the shocks in between blade streamsurfaces. Procedures for generating analytical flow patterns consistent with experiment, including supersonic/subsonic transition through oblique shocks, are demonstrated (Author)

A79-19497 # The effect of intake conditions on supersonic flutter in turbofan engines D. G. Halliwell (Rolls-Royce, Ltd., Aero Div., Derby, England) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan. 15-17, 1979, Paper 79-0044* 7 p 5 refs

The nature of supersonic flutter, to which high tip speed, front stage fans of modern aircraft turbofan engines are susceptible, is introduced briefly. The effect of varying engine intake conditions of altitude, flight speed and ambient temperature are examined and test data is compared with theory. Some important flight conditions for minimum flutter margins in typical civil and military applications are outlined. The effect of engine intake type is then covered with respect to the degree of pressure distortion presented to the fan. A tentative relationship is derived between this distortion and flutter onset speed (Author)

A79-19498 * # An analysis of thermal stress and gas bending effects on vibrations of compressor rotor stages L. T. Chen (McDonnell Douglas Research Laboratories, St. Louis, Mo.) and J. Dugundji (MIT, Cambridge, Mass.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0045* 12 p 9 refs. Grant No. NsG-3079

A preliminary study conducted by Kerrebrock et al. (1976) has shown that the torsional rigidity of untwisted thin blades of a transonic compressor can be reduced significantly by transient thermal stresses. The aerodynamic loads have various effects on blade vibration. One effect is that gas bending loads may result in a bending-torsion coupling which may change the characteristics of the torsion and bending vibration of the blade. For a general study of transient-temperature distribution within a rotor stage, a finite-element heat-conduction analysis was developed. The blade and shroud are divided into annular elements. With a temperature distribution obtained from the heat-conduction analysis and a prescribed gas bending load distribution along the blade span, the static deformation and moment distributions of the blade can be solved iteratively using the finite-element method. The reduction of the torsional rigidity of pretwisted blades caused by the thermal stress effect is then computed. The dynamic behavior of the blade is studied by a modified Galerkin's method. G. R.

A79-19499 # A new approach for solving the vorticity and continuity equations in turbomachinery ducts A. Hamed and S. Abdallah (Cincinnati, University, Cincinnati, Ohio) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0046* 8 p 19 refs. Contract No. F49620-78-0041

Repeated solutions to the continuity and vorticity equations are frequently required in computations of three dimensional flows in turbomachinery passages. When the two equations are nonhomogeneous

previous formulations resulted in two second order differential equations. A new approach is presented here, which is applicable in a generalized two dimensional domain or axisymmetric field. It is based on the definition of a streamlike function which is used to transform these nonhomogeneous first order partial differential equations to a single second order equation with Dirichlet boundary conditions over the solid boundaries. Some applications are presented to show how this new approach can be used to save computer time in numerical flow solutions (Author)

A79-19500 # Three dimensional modelling of cascade flows T. J. Barber (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.) and L. S. Langston (Connecticut, University, Storrs, Conn.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0047* 11 p 40 refs

The development of cascade flow and loss prediction methods requires a detailed understanding of the complex three dimensional flow phenomena. Because of this flow complexity, bent duct and passage approximations for a cascade and reduced forms of the governing equations are frequently resorted to in order to simplify the problem. The presence of strong secondary flows and the need for blade-to-blade periodicity restricts the applicability of these approximations. Experimental data is presented to illustrate the deficiencies in using bent duct and passage geometries to simulate a cascade flow field. Analytic formulations for flows in ducts and passages are used to study specific secondary flow effects. Numerical calculations are also presented to demonstrate these deficiencies. Finally analytic and numerical formulations are discussed in light of the above results (Author)

A79-19501 # Aerodynamic effects of surface cooling-flow injection on turbine transonic flow fields C. J. Studerus (General Electric Co., Aircraft Engine Group, Evendale, Ohio) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0048* 10 p 5 refs

A description is presented of the results of calculations of the aerodynamic effects of surface coolant injection on the transonic blade to blade flow fields of stators and rotors typical of high-performance turbines. These results include the effects of coolant flow injection on the distributions of surface pressure, surface Mach number, and total pressure. Effects regarding the extent and the magnitude of the disturbance to the primary flow away from the blade surfaces are also examined. The effects of cooling injection on surface pressure are found to be local. A local compression occurs immediately upstream of the injected flow, followed by a local overexpansion just downstream of the injected flow. G. R.

A79-19511 # Nonlinear gust loads analysis - Monte Carlo vs describing function analysis R. L. Stapleford and R. J. DiMarco (Systems Technology, Inc., Hawthorne, Calif.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0060* 9 p 6 refs. U.S. Department of Transportation Contract No. FA77WA-3936

Structural loads on the vertical tail of an aircraft with a limited authority yaw damper are calculated. The results of a random input describing function analysis are compared with those of a Monte Carlo simulation. Comparisons of exceedance rates and other statistics are presented. The mission analysis criterion for continuous turbulence is used to establish the design limit load. The describing function analysis consistently underestimates the design limit load for two different authority limits. The cause of this discrepancy is examined, and a simplified procedure is developed to assess the adequacy of linear or describing function analyses (Author)

A79-19512 * # Design study results of a supersonic cruise fighter wing D. S. Miller (NASA, Langley Research Center, High Speed Aerodynamics Div., Hampton, Va.) and R. T. Schemensky (General Dynamics Corp., Fort Worth, Tex.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0062* 9 p 16 refs

A study has been conducted to explore the use of existing aerodynamic techniques to design a new supersonic cruise wing for an existing fighter wind tunnel model. In addition to the usual wing design constraints of lift, pitching moment, and minimum drag, a ground rule was imposed that the wing had to fit on the existing fuselage. Experimental wind tunnel results were obtained for a camber design and a reference flat wing. The flat wing was also fitted with leading edge flaps which approximate the cruise camber design. The experimental results indicate that significant improvements in supersonic cruise capability can be obtained by a new wing designed using existing supersonic aerodynamic techniques (Author)

A79-19513 # A computer-aided aircraft Configuration Development System D P Raymer (Rockwell International Corp., Los Angeles, Calif.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0064* 7 p

A brief description is presented of the conventional procedures for initial aircraft configuration development and of the requirements for computer-aided configuration development. A computer program termed the Configuration Development System (CDS) is outlined which is a minicomputer-resident FORTRAN IV program for interactive graphics development of initial aircraft configuration concepts. Basic capabilities and functional organization are explained, and the advantages and disadvantages of minicomputer usage are discussed. The simplistic user's language is described, along with data base manipulation and interface. An illustrative example shows the initial design of a fighter concept, analysis and modification of drag reduction, and automatic wetted area and volume plot creation. Additional analysis tools are in development. S D

A79-19514 * # Supercritical wing design using numerical optimization and comparisons with experiment M E Lores, P R Smith (Lockheed-Georgia Co., Marietta, Ga.), and R M Hicks (NASA, Ames Research Center, Moffett Field, Calif.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0065* 11 p 12 refs

A numerical minimization scheme is used in conjunction with two-dimensional and three-dimensional inviscid transonic flow analysis codes to provide procedures for wing leading edge aerodynamic design. The procedures are demonstrated in the design of a new leading edge to improve C-141 cruise performance. For the high aspect ratio moderately swept C-141 wing, the 2-D procedure is shown to yield results which are in close agreement with those obtained using the 3-D technique. Although the 2-D approach uses much less computation time than the 3-D technique, the latter requires fewer manhours than the former. Comparisons of predicted and wind tunnel measured performance improvements are presented which verify the design procedures (Author)

A79-19515 # Application of advanced technologies to improve C-141 cruise performance W T Blackerby (Lockheed-Georgia Co., Marietta, Ga.) and J K Johnson (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0066* 12 p 8 refs

Transonic flow theory coupled with numerical optimization schemes were employed to design C-141 wing leading edge modifications for cruise drag reduction. These modifications were tested in the AEDC 16-foot Transonic Facility using a 0.044 scale C-141B model. In addition to the leading edges, two other drag reduction concepts were evaluated: swept wing tips and wing trailing edge anti-drag bodies. Improved C-141 drag rise characteristics were obtained and are shown to be consistent with theoretical predictions. An improvement in M(L/D) of 5.7 percent is projected for the leading edge modification and 7.4 percent for the swept tip modification. Potential fuel and cost savings for the wing modifications are shown thus completing the cycle from the use of new computational methods through design, experimental verification and final evaluation through performance and cost pay-offs (Author)

A79-19516 * # A Mars Airplane Oh really V C Clarke, Jr (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, Calif.), A Kerem (Developmental Sciences, Inc., City of Industry, Calif.), and R Lewis (Lear Siegler, Inc., Santa Monica, Calif.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0067* 13 p 7 refs Contract No. NAS7-100

This paper describes the mission design, scientific utilization, and prototypical design of a Mars Airplane. As a scientific platform, the airplane provides an excellent means of obtaining data in a resolution range intermediate to surface vehicles and orbiters. It has great versatility to perform a variety of missions: conduct aerial surveys, land instrument packages, collect samples, and perform atmospheric sounding. The Mars Airplane has many characteristics of a competition glider on earth. Two versions of the plane, a cruiser, and one with soft landing and takeoff capability, have been designed. Maximum range and endurance are 10,000 km and 31.1 hours with a 40-kg payload (Author)

A79-19520 # An efficient transonic shock-free wing redesign procedure using a fictitious gas method N J Yu (Boeing Co., Seattle, Wash.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0075* 9 p 21 refs Research supported by the Boeing Independent Research and Development Program

A new method for transonic shock free three-dimensional wing design based on the full potential equation is presented. The method locally modifies (i.e., redesigns) the wing surface geometry beneath the supersonic region so as to produce a shock-free flow. Results for a redesigned nonlifting rectangular wing and for a redesigned lifting wing of ONERA M6 planform are illustrated. Significant drag reduction and improved lift-drag characteristics are achieved from the present redesign procedures. Methods of compensating for wing thickness reduction experienced in the redesign process and of correcting for viscous effects are discussed (Author)

A79-19521 * # Design of transonic airfoil sections using a similarity theory D Nixon (NASA, Ames Research Center, Moffett Field, Calif.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0076* 8 p 16 refs

In the present paper, it is shown that numerical optimization is a powerful tool for designing transonic wings and airfoils. Nixon's (1978) similarity theory is extended to cover design optimization problems. Some ground rules for designing shock free airfoils are proposed and their application is demonstrated by examples. Advantages which accrue from integrating similarity theory into the numerical optimization procedure are noted. V P

A79-19522 # The calculation of two-dimensional compressible potential flow in cascades using finite area techniques J R Caspar (United Technologies Research Center, East Hartford, Conn.), D E Hobbs, and R L Davis (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0077* 10 p 10 refs

A rapid and accurate numerical method is presented for the calculation of two-dimensional compressible potential flow in cascades. The integral form of continuity is approximated over finite areas in the physical plane allowing the grid flexibility required by the periodicity, turning, thickness and stagger of cascades of practical interest, and yielding second order accuracy on appropriate meshes. Excellent agreements between predictions and analytic or measured results are shown for subsonic and transonic test cases. A model problem stability analysis supports the experimental observation that the procedure is unconditionally stable for subsonic flow and conditionally stable for transonic flow (Author)

A79-19523 * # An efficient algorithm for numerical airfoil optimization G N Vanderplaats (NASA, Ames Research Center, V/STOL Systems Office, Moffett Field, Calif.) *American Institute of*

Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0079 9 p 11 refs

A new optimization algorithm is presented. The method is based on sequential application of a second-order Taylor's series approximation to the airfoil characteristics. Compared to previous methods, design efficiency improvements of more than a factor of 2 are demonstrated. If multiple optimizations are performed, the efficiency improvements are more dramatic due to the ability of the technique to utilize existing data. The method is demonstrated by application to subsonic and transonic airfoil design but is a general optimization technique and is not limited to a particular application or aerodynamic analysis. (Author)

A79-19524 * # **An efficient user-oriented method for calculating compressible flow about three-dimensional inlets** J L Hess (Douglas Aircraft Co., Long Beach, Calif.) and N O Stockman (NASA, Lewis Research Center, Low Speed Aerodynamics Branch, Cleveland, Ohio) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0081 7 p Contract No NAS3-21135*

This method uses a so-called panel method to calculate incompressible flow about arbitrary three-dimensional inlets with or without centerbodies for four fundamental flow conditions: unit onset flows parallel to each of the coordinate axes plus static operation. The computing time is scarcely longer than for a single solution. A linear superposition of these solutions quite rigorously gives incompressible flow about the inlet for any angle of attack, angle of yaw, and mass flow rate. Compressibility is accounted for by applying a well-proven correction to the incompressible flow. Since the computing times for the combination and the compressibility correction are small, flows at a large number of inlet operating conditions are obtained very cheaply. A number of graphical output features are provided to aid the user, including streamline tracing and automatic generation of curves of constant pressure, Mach number, and flow inclination at selected inlet cross sections. This paper describes the method in some detail and presents calculated results. (Author)

A79-19529 # **The aerodynamic effectiveness of split flare stabilizers** J R Burt, Jr and R A Deep (U.S. Army, Technology Laboratory, Redstone Arsenal, Ala.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0093 7 p*

Aerodynamic characteristics of split flare afterbodies were investigated experimentally to determine their applicability to tube-launched, high acceleration, hypervelocity missiles. Six-petal, twelve-petal, and solid flare configurations were compared at transonic Mach numbers. The six-petal configuration was tested through a large Mach number range at several petal opening angles. The effects of highly underexpanded rocket plumes on aerodynamic stability were investigated. Results are presented which show that split flares are attractive candidates as stabilizing devices. (Author)

A79-19533 * # **Reynolds number, scale and frequency content effects on F-15 inlet instantaneous distortion** C H Stevens, E D Spong (McDonnell Douglas Corp., St. Louis, Mo.), J Nugent (NASA, Flight Research Center, Edwards, Calif.), and H E Neumann (NASA, Lewis Research Center, Cleveland, Ohio) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0104 11 p 6 refs*

An inlet instantaneous distortion study program sponsored by NASA was recently completed using an F-15 fighter aircraft. Peak distortion data from subscale inlet model wind tunnel tests are shown to be representative of full-scale flight test peak distortion. The effects on peak distortion are investigated for engine presence, Reynolds number, scale and frequency content. Data are presented which show that (1) the effect of engine presence on total pressure recovery, peak distortion, and turbulence is small but favorable, (2) increasing the Reynolds number increases total pressure recovery, decreases peak distortion, and decreases turbulence, and (3) increasing the filter cutoff frequency increases the calculated values of both peak distortion and turbulence. (Author)

A79-19534 * # **U.S. aerospace industry opinion of the effect of computer-aided prediction-design technology on future wind-tunnel test requirements for aircraft development programs** S L Treon (NASA, Ames Research Center, Aerodynamics Div., Moffett Field, Calif.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0107 18 p 19 refs*

A survey of the U.S. aerospace industry in late 1977 suggests that there will be an increasing use of computer-aided prediction design technology (CPD Tech) in the aircraft development process but that, overall, only a modest reduction in wind-tunnel test requirements from the current level is expected in the period through 1995. Opinions were received from key spokesmen in 23 of the 26 solicited major companies or corporate divisions involved in the design and manufacture of nonrotary wing aircraft. Development programs for nine types of aircraft related to test phases and wind-tunnel size and speed range were considered. M L

A79-19535 * # **A similarity rule for compressibility and sidewall-boundary-layer effects in two-dimensional wind tunnels** R W Barnwell (NASA, Langley Research Center, Hampton, Va.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0108 8 p 5 refs*

The effect of the sidewall boundary layer on flow in two-dimensional wind tunnels is determined. The small-disturbance and isentropic approximations are made, and the sidewall boundary layer dynamics are modeled with the von Karman momentum-integral equation. The effects of the edge-velocity-gradient term in the sidewall momentum integral, which is usually dominant near the model, and the compressibility term are shown to be similar. It is shown that the effect of sidewall suction around the model is not similar to two-dimensional flow. Comparisons with experiment are made to verify the similarity rule. (Author)

A79-19542 # **Aerodynamic development of a high pressure leading edge blowing boundary layer control system** F W May (Boeing Aerospace Co., Seattle, Wash.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0116 8 p 9 refs* Research sponsored by the Boeing Co.

The desire to achieve STOL performance with the next generation of fighters, bombers, and transport aircraft has led to renewed interest in the use of Leading Edge Blowing Boundary Layer Control (LE-BLC) on wings with Advanced Technology Airfoils. A program was conducted to develop the technology required to design an effective LE blowing BLC system utilizing direct engine high pressure bleed for application to a STOL transport. A description is presented concerning one phase of the overall program. This phase involves the aerodynamic development of the BLC nozzles. Previous aerodynamic studies had shown the desirability to use continuous-slot BLC nozzles. However, there are difficulties regarding the manufacture of the slot nozzles and the maintenance of the design values in service. Therefore, an alternate nozzle design consisting of a row of drilled holes was developed using an experimental approach utilizing static and two-dimensional wind tunnel testing. G R

A79-19543 # **Effect of spanwise blowing on the aerodynamic characteristics of the F-5E** G E Erickson (Northrop Corp., Hawthorne, Calif.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0118 10 p 15 refs*

A description is presented of an investigation which has been conducted to obtain a comprehensive data base on the effect of spanwise blowing on the aerodynamic characteristics of a model of an existing fighter configuration with particular emphasis on high angle-of-attack performance and stability. The effect of blowing on fighter maneuver performance was also evaluated. Test data were obtained in a 7 x 10 foot low-speed wind tunnel at a free-stream

Mach number of 0.18 corresponding to a Reynolds number based on wing mean aerodynamic chord of 1,020,000 for a range of model angle of attack, jet momentum coefficient, nozzle sweep angle, and leading- and trailing-edge flap deflection angles. The results of this investigation indicate that spanwise blowing from the wing/leading-edge extension junction with a nozzle sweep angle of 55 deg generates significant vortex-induced lift increments at the higher angles of attack, improves the drag polars, and extends the linear pitching moment to high lifts. G R

A79-19544 * # A study of the blown flap/jet flap analogy G R Hough (Vought Advanced Technology Center, Inc., Dallas, Tex.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0119* 9 p 21 refs Contract No. NAS2 8115

A study of the blown flap/jet flap analogy has been undertaken. Analytical predictions were made using both improved lifting line and optimized vortex lattice models for the jet flap. Results were compared with experimental data for three propulsive lift systems, the jet augmented flap, the externally blown flap, and the upper surface blown flap. Force increments due to changes in geometry and jet parameters were well approximated in most cases, although the absolute values of the aerodynamic forces were usually underestimated. The relatively simple jet-flap models gave performance predictions of accuracy comparable to more complex analyses. (Author)

A79-19545 * # Calculation of the longitudinal aerodynamic characteristics of upper-surface-blown wing-flap configurations M R Mendenhall and S B Spangler (Nielsen Engineering and Research, Inc., Mountain View, Calif.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0120* 12 p 15 refs Contract No. NAS1-14086

An investigation has been carried out to develop an engineering method for predicting the longitudinal aerodynamic characteristics of wing-flap configurations with upper surface blown (USB) high lift devices. Potential flow models of the lifting surfaces and the jet wakes are combined to calculate the induced interference of the engine wakes on the wing and flaps. The wing may have an arbitrary planform with camber and twist and multiple trailing edge flaps. The jet wake model has a rectangular cross section over its entire length and it is positioned such that the wake is tangent to the upper surfaces of the wing and flaps. Comparisons of measured and predicted pressure distributions, spanload distributions, and total lift and pitching-moment coefficients on swept and unswept USB configurations are presented for a wide range of thrust coefficients and flap deflection angles. (Author)

A79-19546 # The Tri-Fan V/STOL propulsion/control concept J A Sabatella (United Technologies Corp., Pratt and Whitney Aircraft Group, West Palm Beach, Fla.) and G J Howard *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0121* 5 p

The paper deals with the Tri-Fan concept which meets the U.S. Navy V/STOL requirements by blending propulsion, control, and trim features to produce a low-weight propulsion system with low fuel weight, low estimated takeoff weight, and good control characteristics. The key features are the use of three thrust vectors (two laterally spaced thrust vectors forward of the CG and a single thrust vector aft of the CG) to provide stable vertical lift and good control, three engines for good capability with one engine inoperative, and a relatively simple mechanical interconnect system for good control characteristics and engine out-trim. Some potential benefits of the Tri-Fan concept are noted. V P

A79-19553 * # Calculation of transonic aileron buzz J L Steger and H E Bailey (NASA, Ames Research Center, Moffett

Field, Calif.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0134* 13 p 15 refs

An implicit finite-difference computer code that uses a two-layer algebraic eddy viscosity model and exact geometric specification of the airfoil has been used to simulate transonic aileron buzz. The calculated results, which were performed on both the Illiac IV parallel computer processor and the Control Data 7600 computer, are in essential agreement with the original expository wind-tunnel data taken in the Ames 16-Foot Wind Tunnel just after World War II. These results and a description of the pertinent numerical techniques are included. (Author)

A79-19554 * # A numerical study of jet entrainment effects on the subsonic flow over nozzle afterbodies R G Wilmoth (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, Va.), S M Dash, and H S Pergament (Aeronautical Research Associates of Princeton, Inc., Princeton, N.J.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0135* 13 p 25 refs

A viscous-inviscid interaction model has been developed which accounts for jet entrainment effects in the prediction of the subsonic flow over nozzle afterbodies. The jet entrainment model is based on the concept of a weakly interacting shear layer in which the local streamline deflections due to entrainment are accounted for by a displacement-thickness type correction to the inviscid plume boundary. The entire flowfield is solved in an iterative manner to account for the effects on the inviscid external flow of the turbulent boundary layer, turbulent mixing and chemical reactions in the shear layer, and the inviscid jet exhaust flow. The individual components of the computational model are described and numerical results are presented which illustrate the interactive effects of entrainment on the overall flow structure. The validity of the interactive model is assessed by comparisons with data obtained from flowfield measurements on cold-air jet exhausts. Numerical results and experimental data are also given which show the entrainment effects on nozzle boattail drag under various jet exhaust and freestream flow conditions. (Author)

A79-19557 # Boundary layer induced secondary flows due to wing-body interference S G Rubin and J M Lyons (New York, Polytechnic Institute, Farmingdale, N.Y.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0140* 12 p 11 refs Contract No. F49620 78-C 0020 AF Project 2307 AI

Slender body theory is combined with higher order boundary layer concepts in order to determine the boundary layer induced potential flow over wing-body cylindrical cross sections. It is shown that the three-dimensional viscous displacement flowfield can be evaluated, in the vicinity of the surface of the cylinder, by a quasi-two-dimensional slender body procedure. This approximation is valid when the boundary layer is thin, the body is 'slender' in the usual inviscid sense, and there are no geometrical discontinuities. The induced potential flow is determined by conformal mapping techniques. These solutions are obtained in closed form or by quadratures. Complete second order boundary layer solutions are obtained for an elliptical fuselage-wing tail cross-section. (Author)

A79-19562 * # High speed interference heating loads and pressure distributions resulting from elevon deflections C B Johnson (NASA, Langley Research Center Subsonic Transonic Aerodynamics Div., Hampton, Va.) and L G Kaufman, III (Grumman Aerospace Corp., Bethpage, N.Y.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0145* 8 p 12 refs

Effects of elevon-induced three-dimensional shock wave turbulent boundary layer interactions on hypersonic aircraft surfaces are analyzed. Detailed surface pressure and heating rate distributions obtained on wing-elevon-fuselage models representative of aft portions of hypersonic aircraft are compared with analytical and experimental results from other sources. Examples are presented that

may be used to evaluate the adequacy of current theoretical methods for estimating the effects of three-dimensional shock-wave turbulent boundary layer interactions on hypersonic aircraft surfaces (Author)

A79 19564 * # Comparison of two flow surveys above stalled wings W H Young, Jr and D R Hoad (NASA, Langley Research Center, U S Army, Structures Laboratory, Hampton, Va) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La , Jan 15-17, 1979, Paper 79-0147* 10 p 17 refs

A laser velocimeter (LV) surveyed the flow above two stalled wings Each wing was tested in a different wind tunnel at different Mach numbers The low-Mach number test had an angle of attack of 19.4 deg, 0.15 Mach number, and $1 \times 1,000,000$ Reynolds number The mean velocities above the reversed, separated flow were closely modeled by error function profiles Thus, the flow resembled a turbulent free-shear layer The high-Mach-number test had an angle of attack of 19.5 deg, 0.49 Mach number, and 1,400,000 Reynolds number A series of strong, discrete vortices were shed from the airfoil crest at regular intervals Both tests demonstrated the importance of the unsteady part of the velocities (Author)

A79 19567 # Trailing edge conditions for unsteady flows at high reduced frequency S Fleeter (Purdue University, West Lafayette, Ind) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0152* 7 p 8 refs USAF-sponsored research

In the prediction of time-variant flows past airfoils and airfoil cascades the steady-state Kutta-Joukowski condition holds at low reduced frequencies The object of the present study was to investigate the validity of the Kutta-Joukowski condition at high reduced frequencies This was accomplished by measuring the time-variant surface pressure distribution at the trailing end of a classical isolated flat plate, a classical flat plate cascade, and a cambered airfoil cascade (at high reduced frequencies) over a range of incidence angles, and correlating these data with state-of-the-art zero-incidence flat plate models which apply the Kutta-Joukowski condition The results indicate that at high reduced frequency values, the Kutta-Joukowski condition holds for flat plates and flat plate cascades over a wide range of incidence angles For cambered cascades, however, this condition does not appear to be satisfied for any value of incidence angle V P

A79-19585 # Drop formation, evaporation modelling and environmental assessment of JP-4 fuel jettisoned from aircraft R E Good (USAF, Geophysics Laboratory, Bedford, Mass) and H J Clewell, III (USAF, Civil Engineering and Environmental Development Office, Tyndall AFB, Fla) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La , Jan. 15-17, 1979, Paper 79-0186* 9 p 13 refs

The occasional jettison of unburned fuel from aircraft has raised the concern of environmentalists as to possible change in atmospheric composition or damage to crops An experimental program was conducted consisting of flying a sampling aircraft directly through a fuel dump at selected altitudes to measure fuel drop size and number distributions The measurement results of the sampling, fuel dump wake size and hydrocarbon vapor content are presented. A multi-component fuel drop model is used to predict the amount of drop vaporization and determine the initial drop size and number distribution A description of the model will be presented with prediction of the dispersion and fall of the fuel drops The observed drop size distribution is corrected for evaporation using the model to estimate the initial droplet formation size For the KC-135 aircraft fuel venting procedures, the median drop diameter formed is 270 microns It is determined that fuel jettisoned 5000 ft, or higher will evaporate before reaching the ground Ground contamination can be avoided, eliminating any potential environmental damage (Author)

A79-19595 # Fin-cone interference flow field J D Gillerlain, Jr (U S Naval Academy, Annapolis, Md) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La , Jan 15-17, 1979, Paper 79-0200* 8 p 16 refs Navy-sponsored research

The general purpose of this investigation was to study the separated flow field associated with a general fin body or wing-body juncture Specific objectives included (a) determining the severity and extent of interference heating, (b) providing flow visualization experiments to illustrate the flow structure, and (c) gathering a data base of heat transfer and surface-pressure measurements to predict peak interference heating and peak pressure levels A fin-cone configuration was tested at Mach 5 Heat transfer in the interference flow field was measured using the phase-change paint technique Surface pressures were measured on the fin leading edge and on the cone ahead of the fin These quantitative measurements were used in conjunction with both schlieren and oil-flow photographs in an effort to characterize the fin cone interference flow field (Author)

A79-19596 # A transonic wind tunnel interference assessment - Axisymmetric flows S S Stahara (Nielsen Engineering and Research, Inc , Mountain View, Calif) and J R Spreiter (Stanford University, Stanford, Calif) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La , Jan 15-17, 1979, Paper 79-0203* 9 p 18 refs Contract No F44620-75-C-0047, Grant No DAAG29 77-C-0038

A wind tunnel interference assessment concept which presents a rational predictive means of wall interference analysis is evaluated The procedure consists of employing as an outer boundary condition an experimentally-measured pressure distribution along a convenient control surface located inward from the actual tunnel walls Attention has been focused on axisymmetric flows in the transonic regime where tunnel interference is high and where the experimentally-measured conditions on the control surface are of mixed subsonic/supersonic type Based on the transonic small-disturbance equation, results for surface and near flow field pressure distributions are presented for a variety of different slender body shapes These calculations indicate both the accuracy of the procedure as well as its ease of implementation The procedure relates directly to the correctable-interference wind tunnel concept recently suggested (Author)

A79-19597 * # Unsteady thin airfoil theory for transonic flows with embedded shocks M H Williams (Princeton University, Princeton, NJ) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La , Jan 15-17, 1979, Paper 79-0204* 12 p 19 refs Grant No NsG 2194

Classical unsteady thin airfoil theory fails for low frequencies at the subsonic freestream Mach number, because of the formation of a shock wave that shields the forward region of the airfoil from aft generated disturbances In the present paper, the classical thin airfoil theory is modified to account for the presence and induced motion of such shocks The modification consists of taking the steady local Mach number to be a simple step discontinuity, normal to the undisturbed flow, separating two uniform regions Predicted regions are shown to correlate well both with the experiment and finite difference calculations V P

A79-19599 # Dynamic stall at high frequency and large amplitude L E Ericsson (Lockheed Missiles and Space Co , Sunnyvale, Calif) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La , Jan 15-17, 1979, Paper 79-0211* 10 p 30 refs

An earlier developed quasi-steady analytic method has been shown to give predictions that are in good agreement with experimental stall results as long as the oscillation amplitude and frequency are of moderate magnitudes In the present paper this quasi-steady method is extended to include the transient effect of the 'spilled' leading edge vortex, thereby providing simple analytic means for prediction of dynamic stall characteristics at high frequencies and large amplitudes The veracity of the method is demonstrated by critical comparisons with the extensive experiments performed by Carr, et al (Author)

A79-19606 # Unconstrained supersonic cruise and maneuvering configuration concepts R J Krieger, J E Gregoire, and R F Hood (McDonnell Douglas Astronautics Co., St Louis, Mo) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0220* 8 p Contract No F33615-77-C-3037

Configuration concepts are presented which have high lift-to-drag ratios and maneuverability achievable by relieving constraints due to carriage, propulsion and subsystem integration. Noncircular body, lifting body, blended wing-body, wing-body and favorable interference concepts are developed using aerodynamic design criteria derived for climb-cruise-intercept missions. The Hypersonic Arbitrary Body Program (HABP) is evaluated for predicting aerodynamic characteristics. Comparisons of wind tunnel data and predictions are presented. Major features such as a spatular nose, flat bottom, high fineness ratio, ramped nose, planar shape, high wing, end plated wing, and interference channel are shown to enhance aerodynamic characteristics (Author)

A79-19611 # The evaluation and use of flying qualities considerations in conceptual design J R Cathey (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0232* 10 p 6 refs

This paper describes the procedures used to consider flying qualities considerations in conceptual design studies conducted by the Deputy for Development Planning in the Air Force. A flying qualities estimation module has been integrated into the Air Force Interactive Computer Aided Design System, ICAD. The ICAD methodology will have the capability to blend aircraft geometric and flight control system constraints to produce control integrated configurations. Compliance with flying qualities requirements with improved performance is the goal. This methodology includes a linear prediction of longitudinal and lateral-directional stability and control derivatives, a mass properties prediction, a versatile trim mode, a flying qualities characteristic prediction and a multiple level flight control system generation mode. This capability will be illustrated by the use of two typical design studies on a trainer and a transport aircraft (Author)

A79-19613 * # A multi-disciplinary approach to structural design for stochastic loads D W Gross (Vought Technical Center, Hampton, Va) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0238* 9 p 6 refs Contract No NAS1-13500

The development of aircraft gust design techniques is reviewed with emphasis on those techniques applicable to large scale multi-disciplinary closed loop optimization methods. An overall view is presented of the optimization methodology utilized. An analysis is presented wherein the bivariate normal distribution function for a particular loading condition is considered. By use of maximization techniques, functions are derived for stress components along equal probability contours which allow for directionality and autocorrelation effects to be considered. These functions are then applied to the problem being considered and the effects on the structural sizing and weight penalties evaluated against more conventional methods (Author)

A79-19631 # Stability of three-dimensional compressible boundary layers over wings with suction S G Lekoudis *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0265* 13 p 8 refs Research supported by the Lockheed-Georgia Independent Research and Development Program

The problem of the propagation of three-dimensional laminar instabilities in a three-dimensional compressible boundary layer is examined using linear stability theory. The theory is applied to the case of a swept wing with suction. Compressibility is stabilizing especially when the disturbance is of the Tollmien-Schlichting type.

When compressibility is neglected the calculations of the amplification rates and the group velocities agree with existing results, obtained from incompressible theory (Author)

A79-19636 * # The supersonic triplet - A new aerodynamic panel singularity with directional properties F A Woodward (Analytical Methods, Inc., Bellevue, Wash) and E J Landrum (NASA, Langley Research Center, Supersonic Aerodynamics Branch, Hampton, Va) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0273* 8 p 8 refs Contract No NAS1-12900

A new supersonic triplet singularity has been developed which eliminates internal waves generated by panels having supersonic edges. The triplet is a linear combination of source and vortex distributions which provides the desired directional properties in the flow field surrounding the panel. The theoretical development of the triplet is described, together with its application to the calculation of surface pressure on arbitrary body shapes. Examples are presented comparing the results of the new method with other supersonic panel methods and with experimental data (Author)

A79-19643 # Aerodynamic characteristics of an unsteady separated flow M S Francis, J E Keesee (USAF, Frank J Seiler Research Laboratory, Colorado Springs, Colo), J D Lang, G W Sparks, Jr, and G E Sisson (US Air Force Academy, Colorado Springs, Colo) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0283* 14 p 21 refs AF Project 2307-F1

The results of experiments in which an unsteady separating flow was generated on the surface of an airfoil immersed in a subsonic wind tunnel freestream are discussed. An investigation of the global ensemble averaged vorticity field generated by oscillations of a fence-type spoiler located on one surface of the airfoil has confirmed the presence of a dynamically evolving vortex like structure bearing a strong resemblance to the one encountered in classical dynamic stall. The growth and development of the shear layer region is characterized through iso-vorticity contour maps at select phase points during the motion cycle. A detailed description of flow field behavior is provided for several values of the dimensionless spoiler frequency and freestream Reynolds number. The correlation of these results with corresponding surface pressure measurements is also presented (Author)

A79-19644 # Calculation of separated boundary-layer flows T Cebeci (California State University, Long Beach, Calif), E E Khalil (Cairo University, Giza, Egypt), and J H Whitelaw (Imperial College of Science and Technology, London, England) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0284* 13 p 27 refs Research supported by the Atomic Energy Research Establishment and Science Research Council, Contract No N00014-77-C-0073

The forms of recirculating flows can be divided between those which stem from bluff bodies and rapid changes in shape and those from adverse pressure gradients and gradual changes in shape. The latter are usually characterized by a boundary layer growing on a wall with separation occurring without a surface discontinuity. The calculation of this form of separated flow is considered. It is relevant, for example, to confined flows such as those in diffusers and in the angled quail of a coaxial burner and to external flows such as those which occur in airfoils, wings, and ship hulls at high angles of attack. A major purpose of the reported investigation is to describe and compare calculated results obtained from the solution of boundary-layer and elliptic equations and appropriate to a separating boundary-layer flow. Attention is given to equations and boundary conditions, solution methods, turbulence models, wall functions and other boundary assumptions, the solution of elliptic equations, the solution of parabolic equations, straight-sided diffusers, and wedge flows G R

A79-19645 # Calculation of laminar separation bubbles and their effect on airfoil performance W B Roberts (Nielsen Engineer-

ing and Research, Inc., Mountain View, Calif.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0285* 9 p 13 refs Research supported by the Von Karman Institute and Nielsen Engineering and Research

The 'bursting' of leading edge laminar separation bubbles that can occur on moderately thick airfoil sections are the cause of sudden large increase of drag, decrease of lift and change in pitching moment associated with abrupt stall at high angles of attack This paper describes a semi-empirical theory for the description and calculation of the development and bursting of laminar separation bubbles The semi-empirical theory uses an experimental correlation to relate the length of the laminar free shear layer to the free stream turbulence and a modified version of Hortons Method (1969) to calculate the properties and reattachment position of the turbulent shear layer The method is used to predict the development of laminar separation bubbles for NACA airfoils Comparison of these results with NACA experiment shows good agreement (Author)

A79-19659 # Finite element methodology results compared with experimental data for a severely deformed wing in transonic flow T A Street (US Army, Missile Research and Development Command, Redstone Arsenal, Ala.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0304* 9 p

Triangular and quadrilateral elements are compared and the justification for using quadrilateral elements is discussed for devising a 'flexible' wing concept to reach a higher yield limit or transmit/absorb some energy so higher performances could be achieved at lower limits A finite element method has been developed to calculate the flow field about a severely deformed wing in transonic flow Also presented are the deformed wing experimental data and program results taken from the experiment conducted at AEDC The experimental results compare quite favorably with the theoretical results except at the leading and trailing edge singularities and show promise of a technique for solving the problem of stiff wings (Author)

A79-19667 * # Comments on a proposed standard wind hazard environment and its use in real-time aircraft simulations J E Dieudonne (NASA, Langley Research Center, Analysis and Computation Div., Hampton, Va.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0324* 10 p 19 refs

A set of mean wind profiles and associated turbulence models have been proposed by the FAA as a standard wind hazard environment to be used in piloted training and research simulators The 'wind hazard package' is described along with a 'strawman' method of implementation into the real time simulation of NASA's Terminal Configured Vehicle (TCV) Simulation results of both piloted and automatic landings have raised questions about the validity of the wind hazard environment, and the use of a lumped parameter quasi-steady flow aerodynamic model in this environment Areas of discussion will include turbulence models, span and area averaging filters, gust penetration effects, and the need for the addition of terms in the moment equations to represent unsteady flow characteristics (Author)

A79-19671 * # Critical considerations for wind-tunnel testing V/STOL aircraft models R J Margason (NASA, Langley Research Center, Subsonic Transonic Aerodynamics Div., Hampton, Va.) and D R Hoad (US Army, Structures Laboratory, Hampton, Va.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0332* 10 p 31 refs

Low speed wind-tunnel testing of V/STOL aircraft concepts to determine the aerodynamic-propulsion interaction effects during the transition between hover and wingborne flight is a necessary step in the development cycle of this type of aircraft The paper examines factors which must be dealt with to assure that the information obtained in experiments is accurate and representative of the

full scale aircraft modeled Areas of discussion include (1) Proper engine simulation selection and model size constraints as a result of the selection, (2) selection of reference power-off condition for determining propulsion interaction effects, (3) modeling of realistic flight conditions to obtain a comprehensive evaluation of the entire transition performance, and (4) wind tunnel boundary interferences and how these are highly configuration dependent (Author)

A79-19672 # Advances in supersonic configuration design methods A Cenko (Grumman Aerospace Corp., Bethpage, N Y.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0233* 12 p 18 refs

A linearized panel method program developed for the design and analysis of wing body configurations at supersonic speeds (Woodward I) has been modified to permit the user to specify the loading for an arbitrary region of the wing The remaining portion of the wing is then optimized on the basis of the prescribed loading This insures that the final shape will produce the minimum drag possible within the constraints In addition, the design feature has been incorporated into an improved panel method supersonic analysis program (Woodward II) Since this code has the capability of representing bodies of noncircular cross-section, it is expected to prove useful in the design of aircraft configurations with arbitrarily shaped fuselages Comparisons are presented with other known minimum drag solutions which demonstrate the validity of both new techniques (Author)

A79-19673 * # Transition aerodynamics for close-coupled wing-canard configuration J W Paulson, Jr., J L Thomas, and M M Winston (NASA, Langley Research Center, Subsonic-Transonic Aerodynamics Div., Hampton, Va.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0336* 8 p 8 refs

A series of wind tunnel tests have been conducted in the Langley V/STOL tunnel to investigate the low-speed longitudinal aerodynamics of two powered close-coupled wing-canard fighter configurations A brief review is provided of the high angle-of-attack data for the two wing canard configurations tested showing the benefits and problem areas of powered lift A takeoff and landing analysis is presented which defines the area in which a fighter type aircraft must operate in order to achieve 305 m field lengths The wing-canard configuration data are analyzed in detail showing the problems of obtaining high lift, high drag, and trimmed moments Assuming that power will be used to trim the aircraft, data are presented comparing the transition aerodynamics of the wing-canard configuration using a nose jet with several V/STOL configurations G R

A79-19674 # Fluid-structure interaction dynamics in fuel cells M A Ferman and W H Unger (McDonnell Aircraft Co., St Louis, Mo.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0237* 9 p 9 refs Research sponsored by the McDonnell Aircraft Co

A description is presented of the fluid/structural interaction in fuel cell cavities Tank wall oscillations create fluid disturbances that produce mass effects modifying dry panel dynamics The fluid disturbances are represented by velocity profile terms satisfying fluid dynamic fundamentals for incompressible fluids The velocity profiles provide a means for describing fluid kinetic energy and hence mass effects in vibratory equations of motion for the panel/fluid systems Two basic ideas were used to solve the vibration equations, namely, a Rayleigh-Ritz or modal approach, and a mini-finite element approach Formative applications of fluid/structure interaction were made in the areas of fatigue, flutter, and hydraulic ram G R

A79-19675 # Aerodynamic and thermodynamic characteristics of flow fields below VTOL vehicles in ground proximity A Karemaa, H A Weber (General Dynamics Corp., Convair Div., San

Diego, Calif.), and C W Smith (General Dynamics Corp., Fort Worth, Tex.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0338* 15 p 8 refs Contract No N00014 76-C-0698

The characteristics of fountains below hovering multi-nozzle VTOL vehicles have been determined from experimental data. Specifically, the thermodynamic and entrainment parameters of the fountain core, and the effects of the blocking surface on the fountain and of the fountain on ground jet entrainment are presented. The fountain-related interference effects are also discussed. It is found that the thermodynamic characteristics of the fountain are significantly higher than predicted, that the interference effects are of the same magnitude as the fountain-core-produced forces, and that the fountains lose mass or have negative entrainment characteristics under certain conditions (Author)

A79-19678 # Subsonic and transonic similarity rules for jet-flapped wings H W Woolard (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0343* 11 p 12 refs

Linear-subsonic and nonlinear transonic similarity rules are presented for a finite-span jet-flapped wing with partial or full-span blowing. The nonlinear rules are new and the linear rules are more general than previous ones. The rules employ a new second-order jet-momentum coefficient similarity parameter which includes the effect of the jet-supply pressure ratio. The second-order effect is found to be significant only when convergent-jet-nozzle choking occurs at a low flight Mach number. Although the experimental data available for validation of the linear rules is sparse and uncertain, some comparisons are made and fair agreement is achieved. Camber-line effects are found to be significant. There is no experimental data suitable for validation of the nonlinear rules. Motivation for this work is the possible use of pure jet flaps for maneuvering combat aircraft at high subsonic and transonic speeds (Author)

A79-19679 * # Computation of aerodynamic interference effects on oscillating airfoils with controls in ventilated subsonic wind tunnels J A Fromme and M A Golberg (Nevada, University, Las Vegas, Nev.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0346* 14 p 37 refs Grant No NSG-2140

Lift interference effects are discussed based on Bland's (1968) integral equation. A mathematical existence theory is utilized for which convergence of the numerical method has been proved for general (square-integrable) downwashes. Airloads are computed using orthogonal airfoil polynomial pairs in conjunction with a collocation method which is numerically equivalent to Galerkin's method and complex least squares. Convergence exhibits exponentially decreasing error with the number n of collocation points for smooth downwashes, whereas errors are proportional to $1/n$ for discontinuous downwashes. The latter can be reduced to $1/n$ to the $m+1$ power with m th order Richardson extrapolation (by using $m = 2$, hundred-fold error reductions were obtained with only a 13% increase of computer time). Numerical results are presented showing acoustic resonance, as well as the effect of Mach number, ventilation, height-to-chord ratio, and mode shape on wind tunnel interference. Excellent agreement with experiment is obtained in steady flow, and good agreement is obtained for unsteady flow (Author)

A79-19680 # Green's function method for the computational aerodynamic analysis of complex helicopter configurations P Soohoo, R B Noll (Aerospace Systems, Inc., Burlington, Mass.), L Morino (Boston University, Boston, Mass.), and N D Ham (MIT, Cambridge, Mass.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0347* 10 p 40 refs Grant No DAAJ02 75-C 0041

An investigation has been conducted to demonstrate the use of the Green's function method to study potential incompressible helicopter aerodynamics with particular application to rotor wake effects on hub/pylon flow. The theoretical formulation for incom-

pressible potential aerodynamics with separated flow presented here is incorporated in the computer program SHAPES (Subsonic Helicopter Aerodynamic Program with Effects of Separation). Extensive numerical results are shown which illustrate the flexibility and accuracy of the formulation. Comparisons with several existing analytical and experimental results are made (Author)

A79-19681 * # Supersonic propeller noise in a uniform flow W-H Jou (Flow Research Co., Kent, Wash.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0348* 7 p 8 refs Contract No NAS2-9807

The reported investigation is concerned with an extension of a theory presented by Hawkings and Lowson (1974). The extension considers also forward flight. Attention is given to the retarded potential solution of the convected wave equation, the Fourier components of acoustic pressure, the zones of relative silence and Doppler amplification, and the asymptotic evaluation of a noise field for a large wave number. The discussed analysis provides the Fourier coefficients of the acoustic signature of a supersonic rotor in a uniform flow. The results are represented by an integral over the blade planform which must be evaluated numerically. The fast Fourier transform can be employed for the Fourier inversion. G R

A79-19683 * # Pressure and velocity measurements in a three dimensional wall jet G D Catalano (USAF, Flight Dynamics Laboratory, Wright Patterson AFB, Ohio), J B Morton, and R R Humphris (Virginia, University, Charlottesville, Va.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0352* 10 p 9 refs NSF Grant No 7522488, Grant No NGR-47-005 219

In three recent papers, some results of an experimental investigation of a freely expanding coflowing jet as well as a three dimensional wall jet have been presented. A flat plate as well as a curved wall surface intended to model a wing-flap combination in a high lift V/STOL configuration have been investigated. In these papers, the ratio of the jet exit plane velocity to the free stream velocity, was 5.1. This paper explores the effects of increasing the velocity ratio. The quantities measured include the width of the mixing region, the mean velocity field, turbulent intensities and time scales. In addition, wall and static pressure-velocity correlations and coherences are presented. The velocity measurements are made using a laser Doppler velocimeter with a phase locked loop processor. The fluctuating pressures are monitored using condenser type microphones (Author)

A79-19685 # Modeling parameter influences in gas turbine combustor design A S Novick, G A Miles (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, Ind.), and D G Lilley (Oklahoma State University, Stillwater, Okla.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0354* 10 p 12 refs

Complementary to the lengthy and costly experimental approach to gas turbine combustor development is the theoretical approach. In order to advance the combustor design process a computer program is needed which starts from hypotheses about the fundamental processes and predicts the distributions of velocity, concentrations, and temperature. Consideration is given in this paper to recent work in the development and application of a primitive-variable finite difference solution procedure for turbulent, reacting, swirling, recirculating flows in axisymmetric combustors. The principal interest is on application of the analysis to gas turbine combustors and on demonstration of the utility and predictive capability of the code as an aid in combustor design (Author)

A79-19686 * # Critical influence of finite rate chemistry and unmixedness on ignition and combustion of supersonic H₂-air streams J S Evans and C J Schexnayder, Jr (NASA, Langley Research Center, High Speed Aerodynamics Div., Hampton, Va.)

American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0355 9 p 7 refs

Good agreement has been obtained between published profiles of composition and pitot pressure and the calculated results from a computer program in which finite rate chemistry was used. Significant differences are noted between results calculated using 7 species and 8 reactions and those calculated using 12 species and 25 reactions. Differences are also found between results in which the effect of unmixedness on reaction in turbulent flow is applied or is not applied (Author)

A79-19687 # A characteristic time correlation for combustion inefficiency from alternative fuels. D. A. Schmidt (Avco Corp., Avco Lycoming Div., Stratford, Conn.) and A. M. Mellor (Purdue University, West Lafayette, Ind.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0357* 11 p 24 refs. Army-sponsored research

Gas turbine engines in tanks and helicopters should be capable of at least emergency service with any fuel. Long term operation of the same vehicles, as well as aircraft, will involve alternative fuels from non-petroleum sources. Non-aviation specification fuels how ever affect engine performance and in particular combustion efficiency. A characteristic time model correlation is examined with fuels representative of future alternatives with emphasis on viscosity and volatility effects upon efficiency. Results from heavier fuels as examined on a disc stabilized research combustor are compared with those from present day aviation fuels. A ratio of a chemical kinetic time to a turbulent mixing time in the shear layer surrounding the flame stabilizing recirculation zone correlates data for mixing controlled flames and a new characteristic time relevant to the fuel injection process is introduced which collapses geometry effects well for a given fuel but which fails to correlate individual fuel effects completely. Progress made to date with inclusion of heterogeneous effects in characteristic time correlations is detailed, and further requisite research is suggested (Author)

A79-19688 * # A model of transverse fuel injection applied to the computation of supersonic combustor flow. R. C. Rogers (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, Va.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0359* 12 p 20 refs

A two-dimensional, nonreacting flow model of the aerodynamic interaction of a transverse hydrogen jet within a supersonic main stream has been developed. The model assumes profile shapes of mass flux, pressure, flow angle, and hydrogen concentration and produces downstream profiles of the other flow parameters under the constraints of the integrated conservation equations. These profiles are used as starting conditions for an existing finite difference parabolic computer code for the turbulent supersonic combustion of hydrogen. Integrated mixing and flow profile results obtained from the computer code compare favorably with existing data for the supersonic combustion of hydrogen (Author)

A79-19698 * # Calculation of the three-dimensional flow field in supersonic inlets at angle of attack using a bicharacteristic method with discrete shock wave fitting. J. Vadyak, J. D. Hoffman (Purdue University, West Lafayette, Ind.), and A. R. Bishop (NASA, Lewis Research Center, Wind Tunnel and Flight Div., Cleveland, Ohio) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0379* 11 p 11 refs. Grants No. NGR-15-005-162, No. NGR-15-005-191

An analysis is presented for calculating the flow field in supersonic mixed-compression aircraft inlets operating at angle of attack. The flow field is computed by a steady three-dimensional bicharacteristic method. The bow shock wave and the reflected internal shock wave system are computed by a three-dimensional discrete

shock wave fitting procedure. Viscous and thermal diffusion may be included as source terms in the bicharacteristic method. A production type computer program capable of determining the flow field in a variety of axisymmetric mixed-compression supersonic inlets is available. The results of the present analysis agree well with those produced by the two-dimensional method of characteristics when axisymmetric flow fields are computed. For three-dimensional flow fields, the results of the present analysis agree well with experimental data except in regions of high viscous interaction and boundary layer removal. The present analysis does not compute the boundary layer, nor does it account for boundary layer bleed (Author)

A79-19699 # Geometric scaling and performance of dump combustors with vortex amplification and swirl generation by gas jets. P. R. Choudhury (Southern California, University, Los Angeles, Calif.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0382* 7 p 5 refs. Grant No. AF AFOSR 77 3354

Sudden expansion burners (dump combustors) are being investigated as possible candidates for advanced air-breathing propulsion systems which are compact, smooth burning, and highly efficient. Unfortunately, there are a number of difficulties related to low flame spreading, fuel droplet evaporation problems, and rough burning. In order to remove some of the deficiencies of the basic dump burner concept, a slight modification has been proposed. In the modified burner, small gas jets located upstream of the dump plane are used for vortex amplification. A description is presented of a series of experiments conducted to explore approaches for improving the design of dump combustors. The first objective of these experiments was to determine if the jet system can perform effectively in a high temperature, high pressure environment with choked burner nozzle. The second objective was to ascertain if it will be possible to predict the performance of a larger burner operating at higher pressures and temperatures, from known behavior of smaller laboratory scale burners at lower pressures and temperatures. G. R.

A79-19700 # Effect of injection angle on liquid injection in supersonic flow. S. I. Baranovskii and J. A. Schetz (Virginia Polytechnic Institute and State University, Blacksburg, Va.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0383* 10 p 6 refs. USAF supported research

Liquid jet injection into supersonic flow was studied experimentally over a wide range of geometrical and gasdynamic parameters. The results indicate that from a basic gasdynamic point of view, injection from the top of a strut is essentially equivalent to that for flat plate or wall injection. Injection of liquid fuels from the top of a strut is a simple method of increasing penetration without increasing combustion chamber length. On the basis of numerous experiments, it proved possible to develop a new correlation formula for evaluating the penetration of a liquid jet into a supersonic flow in very general situations, including the effects of nozzle diameter and shape, angle of injection, distance from injector, freestream parameters, and adjacent flow rate. V. P.

A79-19701 # Development of an integral fuel injection concept for staged combustors. R. S. Reilly, R. G. Holm (United Technologies Corp., Pratt and Whitney Aircraft Group, West Palm Beach, Fla.), J. B. Kennedy (United Technologies Research Laboratories, East Hartford, Conn.), and K. N. Hopkins (USAF, Aero Propulsion Laboratory, Wright Patterson AFB, Ohio) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La, Jan 15-17, 1979, Paper 79-0384* 8 p 8 refs

An integral fuel injection concept for application to advanced high temperature rise and/or low emission combustors is defined with emphasis on the experimental methodology utilized to characterize the injector. The integral fuel nozzle design philosophy is discussed relative to conventional fuel nozzle configurations. Results on droplet size and vaporization rates obtained from a two-dimensional representative combustor section with holographic photography are presented. Analytical prediction of the behavior of the fuel spray in a combusting environment is included. The paper

will be concluded with a description of the nozzle configuration selected for evaluation in an advanced combustor rig program

(Author)

A79-19702 # Definition of electronic engine control environment for an advanced aircraft engine C B Kunkle and M E McGlone (United Technologies Corp., Pratt and Whitney Aircraft Group, West Palm Beach, Fla.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0385* 7 p 5 refs

The objective of this study was to define the environment for an electronic control mounted on an advanced engine in a high performance aircraft. Two typical missions and a flight envelope were generated for the application. A computer simulation was operated at 15 flight points around the perimeter of the flight envelope to define the extreme environmental conditions and was executed at 10 predicted flight points in each mission to define typical environmental conditions. Three methods were evaluated for fuel cooling sources. These were tank fuel cooling, engine boost pump inlet fuel cooling, and engine boost pump discharge fuel cooling. The physical environment of vibration, shock, and acceleration loads was defined based on engine rotor speeds, fan and compressor blade passing frequencies, and fuel pump induced vibration. The electrical environment anticipated for the study system was defined. An assessment of moisture was made by defining the liquid vapor content of the air due to environmental weather conditions and altitude.

(Author)

A79-19710 * # Maximum likelihood identification of aircraft parameters with unsteady aerodynamic modelling D A Keskar (Cincinnati, University, Cincinnati, Ohio) and W R Wells (Wright State University, Dayton, Ohio) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0400* 10 p 6 refs. Grant No. NsG-1417

A simplified aerodynamic force model based on the physical principle of Prandtl's lifting line theory and trailing vortex concept has been developed to account for unsteady aerodynamic effects in aircraft dynamics. Longitudinal equations of motion have been modified to include these effects. The presence of convolution integrals in the modified equations of motion led to a frequency domain analysis utilizing Fourier transforms. This reduces the integro-differential equations to relatively simple algebraic equations, thereby reducing computation time significantly. A parameter extraction program based on the maximum likelihood estimation technique is developed in the frequency domain. The extraction algorithm contains a new scheme for obtaining sensitivity functions by using numerical differentiation. The paper concludes with examples using computer generated and real flight data.

(Author)

A79-19713 * # Numerical comparisons of panel methods at subsonic and supersonic speeds J L Thomas and D S Miller (NASA, Langley Research Center, Hampton, Va.) *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 17th, New Orleans, La., Jan 15-17, 1979, Paper 79-0404* 10 p 13 refs

Numerical comparisons between some recently developed surface panel methods and well-established methods are made to assess their accuracy at subsonic and supersonic speeds. The results at subsonic speeds indicate similar improvements for the methods investigated over the low order source method. At supersonic speeds, stable and accurate results were obtained with the surface panel methods. Significant differences between tangential mass flux and tangential velocity boundary conditions occurred, especially at low fineness ratios and higher Mach numbers. The advantages of the general source/doublet panel formulation at both subsonic and supersonic speeds are noted.

(Author)

A79-19717 * # Experimental investigation of the buckling characteristics of a beaded skin panel for a hypersonic aircraft - Including comparisons with finite element and classical analyses W H Siegel (California, University, Lawrence Livermore Laboratory, Livermore, Calif.), R A Fields (NASA, Flight Research Center,

Edwards, Calif.), and J T Easley (Kansas, University, Lawrence, Kan.) *American Society of Mechanical Engineers, Winter Annual Meeting, San Francisco, Calif., Dec 10-15, 1978, Paper 78-WA/Aero-3* 8 p 16 refs. Members, \$1 50, nonmembers, \$3 00

Results of a compression test of a beaded panel intended for a proposed hypersonic aircraft are presented. The panel was tested to failure at room temperature to determine its buckling characteristics, in particular, to study the buckling caused by pure compression. The boundary conditions of the panel simulated as nearly as possible a wing mounted condition. Strain, out of plane deflection, and load data were measured, and elastic buckling strength as well as mode shapes of the panel were determined. Application of the moire technique is described.

M L

A79-19723 # The CH-46 rotor blade transition from metal to composite materials B E Gardner and G H Thompson (Boeing Vertol Co., Philadelphia, Pa.) *American Society of Mechanical Engineers, Winter Annual Meeting, San Francisco, Calif., Dec 10-15, 1978, Paper 78-WA/Aero-9* 9 p. Members, \$1 50, nonmembers, \$3 00

To increase reliability and decrease maintenance requirements associated with metal rotor blades on the CH 46 helicopter, the Boeing Vertol Company contracted to design a new composite rotor blade having fiberglass as its primary material. This paper describes the major aspects of the design process by which metal blade structural and aerodynamic properties were effectively duplicated using composite materials.

(Author)

A79-19725 # A reliable spline coupling H W Brown (ARINC Research Corp., Annapolis, Md.) *American Society of Mechanical Engineers, Winter Annual Meeting, San Francisco, Calif., Dec 10-15, 1978, Paper 78-WA/Aero-11* 8 p 10 refs. Members, \$1 50, nonmembers, \$3 00. Navy supported research.

Involute spline couplings are commonly used in aircraft to transmit power to gearboxes, generators, pumps, and other engine driven accessories. Spline-driven accessories which are cantilever mounted on an aircraft engine are of special concern to the user as these interface splines characteristically exhibit extremely poor reliability. To compound the problem, replacement of splines is difficult and costly due to their inaccessibility. Whereas the engine driven accessory may demonstrate a mean time between failures of 2000 hr, the spline coupling typically fails within 500 hr. Consequently, the degree of maintenance demanded by spline wear conflicts with the operational requirements of military or commercial aircraft. Failures can also compromise flight safety. This paper reviews recent spline research directed at understanding the characteristics and problems of conventional involute splines. It also discusses the design, development, and application of the circular spline coupling which was developed to solve spline wear problems being experienced in military aircraft.

(Author)

A79-19762 # Design and development of a rotating water table for flow studies in turbomachine stages N F Rieger, A L Wicks (Rochester Institute of Technology, Rochester, N Y.), and A B Dodd *American Society of Mechanical Engineers, Winter Annual Meeting, San Francisco, Calif., Dec 10-15, 1978, Paper 78-WA/DE-16* 13 p 24 refs. Members, \$1 50, nonmembers, \$3 00. Navy-supported research.

The paper describes a rotating water table apparatus which uses a flow of water to model the gas flow conditions in a turbomachine stage. The device has a circular row of stationary inlet guide vanes mounted on a horizontal flat surface, and a circular row of moving blades rotates concentrically around the stationary vanes. The device has been used to study nonsteady forces acting on a moving blade as well as associated flow conditions. Sample results of these studies are reported, and the determination of the influence of stage parameters such as nozzle profile, blade profile, and gaging is considered. Capabilities and limitations of the device are examined.

M L

A79-19772 # Optimal control of turbine engines R L De Hoff and W E Hall, Jr (Systems Control, Inc., Palo Alto, Calif.) *American Society of Mechanical Engineers, Winter Annual Meeting,*

San Francisco, Calif., Dec 10-15, 1978, Paper 78-WA/DSC 33 16 p 35 refs Members, \$1 50, nonmembers, \$3 00 Contract No F33615-75-C-2053

Multivariable control design for turbine engines has been studied for over 20 years. In the last 10 years, the application of linear, optimal design techniques has produced a number of turbine engine controllers. A group of these design procedures is described and a discussion of the procedures' performance, complexity and implementation is presented. The design of a full-envelope controller for the F100 turbofan engine based on linear, optimal synthesis and locally linear modeling techniques is discussed. A perspective of optimal control design for turbine engines is presented and the future is examined (Author)

A79-19790 # Thermophoresis - Enhanced deposition rates in combustion turbine blade passages. G Vermes (Westinghouse Electric Corp., Combustion Turbine Systems Div., Eddystone, Pa.) *American Society of Mechanical Engineers, Winter Annual Meeting, San Francisco, Calif., Dec 10-15, 1978, Paper 78-WA/GT-1* 5 p 9 refs Members, \$1 50, nonmembers, \$3 00

Thermophoresis is proposed as an explanation of the finding that, in turbine cascades, the temperature difference between the cooled wall and the hot working gas significantly increases the deposited fraction of the solid material. Thermophoresis involves the movement of small particles toward colder regions under the influence of a thermal gradient in the continuum surrounding them, and a thermophoresis calculation procedure based on the Einstein/Epstein formula and simplified cascade considerations is presented. Results are compared with laboratory and field data. The percentage of material deposited is also referred to as the catch efficiency. Data from residual oil-burning turbines show that a 300 C temperature difference between gas and wall can cause a fifteenfold increase in deposition rate as compared with the case of the adiabatic cascade. M L

A79-19791 # Design and development of a monorotor gas turbine auxiliary power unit. C Rodgers *American Society of Mechanical Engineers, Winter Annual Meeting, San Francisco, Calif., Dec 10-15, 1978, Paper 78-WA/GT-2* 13 p Members, \$1 50, nonmembers, \$3 00

A description is presented of the design and development phase of the T-62T-42 monorotor which was shown to fulfill all its design objectives and satisfactorily perform a 50-hour endurance run. The monorotor engine represents one possible solution to a high-temperature, low-cost, small gas turbine. In the monorotor engine a single-stage radial compressor and turbine are integrated back to back and the hot turbine is directly cooled by the cold compressor. A noncontact tip seal is provided to isolate the compressor and turbine flow paths through which a small fraction of throughflow leakage is intentionally directed to serve as additional turbine hub film cooling. Attention is given to aspects of compressor design and influence of heat transfer, questions of turbine design and heat transfer, the monostator design, tip seal considerations, a thermal analysis, a monorotor stress analysis, a T-62T-42 engine description, and a performance evaluation. G R

A79-19792 * # Viscous flow analysis in mixed flow rotors. I Khalil, W Tabakoff, and A Hamed (Cincinnati, University, Cincinnati, Ohio) *American Society of Mechanical Engineers, Winter Annual Meeting, San Francisco, Calif., Dec 10-15, 1978, Paper 78-WA/GT-3* 15 p 18 refs Members, \$1 50, nonmembers, \$3 00 Contract No NAS2 7850

A method for analyzing the viscous flow through turbomachine rotors is presented. The field analysis is based upon the solution of the full Navier Stokes equations over the rotor blade to-blade stream channels. An Alternating-Direction-Implicit method is employed to carry out the necessary numerical integration of the elliptic governing equations. The flow analysis may be applied to various types of turbomachine rotors. Preliminarily, only the case of laminar flows are considered in this paper. The flow characteristics within the

rotors of a mixed flow turbine and a radial bladed compressor are investigated over a wide range of operating conditions. Excellent results are obtained when compared with existing experimental data. The method of this analysis is quite general and can deal with a wide range of applications. Possible modification of the present study to deal with turbulent flow cases are also identified (Author)

A79-19793 # Numerical investigations on the generation and development of rotating stalls. M Pandolfi and G Colasurdo (Torino, Politecnico, Turin, Italy) *American Society of Mechanical Engineers, Winter Annual Meeting, San Francisco, Calif., Dec 10-15, 1978, Paper 78-WA/GT 5* 10 p 14 refs Members, \$1 50, nonmembers, \$3 00 Consiglio Nazionale delle Ricerche Contract No 115,9299-CT77,00122,07

A time-dependent technique is used for numerically predicting the distorted steady and unsteady flow in axial compressors. The bladings are modeled as actuator disks with turning and loss characteristics based on the experimental performances of the corresponding cascades. The full equations are written for the unsteady compressible and two dimensional (high hub-to-tip ratio blading) flows. Peripheral maldistributions of different kinds are considered. The integration in time of the flow equations is based on a finite difference procedure. Steady distorted flows are computed as the configuration asymptotic in time, following a transient. In the case of low mass flow rate, no stable distorted flows are found, but flow instabilities, such as rotating stalls, are generated. Results are presented on the origin and development of these stalls (Author)

A79-19794 # Development of a new flame sprayed erosion resistant abrasadable coating system. J D Reardon and F N Longo (Metco, Inc., Westbury, N Y) *American Society of Mechanical Engineers, Winter Annual Meeting, San Francisco, Calif., Dec 10-15, 1978, Paper 78-WA/GT-6* 8 p Members, \$1 50, nonmembers, \$3 00

A new coating concept for producing an erosion resistant abrasadable coating (ERAC) system is proposed. Using either the plasma or combustion spray process, an abrasadable coating is sprayed in conjunction with an erosion resistant coating to produce a coating system with excellent abrasadability and high degree of erosion resistance (Author)

A79 19795 # Development of sprayed ceramic seal system for turbine gas path sealing. L T Shiembob, O L Stewart (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.), and R C Bill (US Army, Air Mobility Research and Development Laboratory, Cleveland, Ohio) *American Society of Mechanical Engineers, Winter Annual Meeting, San Francisco, Calif., Dec 10 15, 1978, Paper 78-WA/GT-7* 7 p 8 refs Members, \$1 50, nonmembers, \$3 00

Analytical and experimental research was conducted to evaluate a ceramic seal system for a high-pressure turbine employing plasma-sprayed graded metallic ceramic, yttria-stabilized zirconium oxide (YSZ). The performance characteristics of several YSZ configurations were determined through rig testing for thermal shock resistance, abrasadability and erosion resistance. Results and test data acquired from this work indicate that this type of sealing system offers the potential to meet the operating requirements of future gas-turbine engines. However, continued development and refinement of this technology, particularly in the area of improving cyclic thermal stress tolerance, is necessary (Author)

A79-19798 # Engine life usage experience of YF17/YJ101 flight and ground testing. W A Troha (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio) *American Society of Mechanical Engineers, Winter Annual Meeting, San Francisco, Calif., Dec 10-15, 1978, Paper 78-WA/GT-11* 7 p Members, \$1 50, nonmembers, \$3 00

The suitable definition and utilization of engine component life for the determination of maintenance intervals during a prototype development program is demonstrated. A 15,000 pound thrust, two-spool, low by-pass turbofan engine is used for the demonstration. Differences between engine component life definitions during the

design, ground acceptance, and flight test phases of the program are discussed. The use of flight recorded data was used to define and run the engine to a simulated mission ground test cycle. Attention is given to the design requirements, a preliminary flight rating test, the maintenance concept, aspects of flight test data collection and analysis, the automated reduction of engine flight data, and an accelerated ground engine simulated mission test. G R

A79-19799 # Screening properties of silicon-base ceramics for turbine engine applications D C Larsen, G C Walther, S A Bortz (IIT Research Institute, Chicago, Ill.), and R Ruh (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio) *American Society of Mechanical Engineers, Winter Annual Meeting, San Francisco, Calif., Dec 10-15, 1978, Paper 78-WA/GT-12* 7 p 15 refs. Members, \$1 50, nonmembers, \$3 00

Over twenty Si₃N₄ and SiC materials have been evaluated as a part of a continuing program to characterize ceramics for turbine engine applications. Hot-pressed, reaction bonded, and pressureless sintered forms are included. The materials studied range from commercially available to highly developmental. Properties were measured in air from 25 C to 1500 C, and include flexural strength, modulus, and stress strain, creep and stress rupture, fracture toughness, thermal expansion, thermal diffusivity, thermal shock resistance, and strength changes due to long term oxidation exposure. The current status of part of the data generated is summarized, with emphasis placed on predominate behavioral trends for each material type to aid the designer in materials selection. (Author)

A79-19800 # Progress on the ENSIP approach to improved structural integrity in gas turbine engines - An overview C F Tiffany and W D Cowie (USAF, Systems Command, Wright-Patterson AFB, Ohio) *American Society of Mechanical Engineers, Winter Annual Meeting, San Francisco, Calif., Dec 10-15, 1978, Paper 78-WA/GT-13* 12 p 5 refs. Members, \$1 50, nonmembers, \$3 00

The paper describes the turbine engine structural integrity program (ENSIP), defined as an organized and disciplined approach to the structural design analysis, development, production, and life management of gas turbine engines with the goal of ensuring engine structural safety, increasing service readiness, and reducing life cycle costs through substantially reducing the occurrence of structural durability problems during service operations. ENSIP was applied in the F-101 engine development program. Topics discussed include damage tolerance, durability, ground and flight verification test policy and guidelines, and engine life management policy. M L

A79-19801 # A cumulative fatigue damage model for gas turbine engine disks subjected to complex mission loading T A Cruse and T G Meyer (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.) *American Society of Mechanical Engineers, Winter Annual Meeting, San Francisco, Calif., Dec 10-15, 1978, Paper 78-WA/GT-14* 11 p 7 refs. Members, \$1 50, nonmembers, \$3 00. Contract No. F33615 75-C-2063

The objective of a continuing research program is to develop a low cycle fatigue (LCF) damage model which accurately evaluates the life exhaustion of military gas turbine engine disks subjected to complex loading spectra. This paper reports the results of the first phase of the effort and specifically concerns 'cold region' disk bolt holes. A simple cycle LCF model is developed which accounts for nonlinear material behavior and the presence of local surface residual stresses due to machining. Nonlinear cumulative damage is clearly observed in specimen and component testing and is successfully modeled by a 'double damage' principle in which an initial crack length need not be known explicitly. Testing of full-scale components under complex loading is used to verify the models. (Author)

A79 19802 # A procedure for axial blade optimization P F W de Neeve (Pratt and Whitney Aircraft of Canada, Ltd., Longueuil, Quebec, Canada) and R V Dukkupati (National Research Council,

Ottawa, Canada) *American Society of Mechanical Engineers, Winter Annual Meeting, San Francisco, Calif., Dec 10-15, 1978, Paper 78-WA/GT-15* 8 p 5 refs. Members, \$1 50, nonmembers, \$3 00

This paper proposes a method of stress optimization of axial blades without comprising the aerodynamic design. The method is most relevant to flexible element techniques, which have given accurate results for stresses and deflections of shell structures. The aerodynamic definition of the blade is taken as the initial geometry. A modified geometry is obtained through the use of small variations from the initial shape, giving an optimum stress distribution and matching in its loaded, deflected, condition the original aerodynamic definition. An example of a representative blade design is included, which illustrates the practical validity of this approach. (Author)

A79-19853 An overview of the Space Shuttle Orbiter Communication and Tracking System L M Carrier and W S Pope (Rockwell International Corp., Space Div., Downey, Calif.) *IEEE Transactions on Communications*, vol. COM 26, Nov 1978, pt. 1, p. 1494-1506

The Orbiter Communications and Tracking (C and T) System must interface with not only the NASA Spaceflight Tracking and Data Network, but also the NASA Tracking and Data Relay Satellite System, the USAF Satellite Control Facility, other satellites, crew members performing extravehicular activities (EVA), the FAA Air Traffic Control (ATC) voice communications, and FAA and military air navigational aids. Subsystem functional descriptions are presented, taking into account UHF transceivers, the EVA/ATC Communication System, the audio distribution system, air navigation aids, the S-band system, the Ku-band radar/communication system, the television system, ground command interface logic, and antennas. Displays and controls are also considered and a physical description of the system is provided. G R

A79-19897 # Kiebitz Do 34 - The German contribution to the ARGUS program U Gittner *Dornier Post* (English Edition), no. 3, 1978, p. 6-8

The Kiebitz is a tethered rotor platform consisting of the flight vehicle and the ground station tether. Along with the Orpheus II radar system it forms the Argus battlefield surveillance system. Flight testing of the first prototype has begun, the object being to test overall functioning, flight performances, flight characteristics, controllability, tether behavior, and influence of external HF radiation. It has been proved that the hovering vehicle can lift a 140-kg payload to an altitude of 300 m. Ground tests have shown the airworthiness of the radar in simulated Argus mission conditions. P T H

A79-19900 # Helicopter flight control /HSF/ D Batzlen and H Seelmann *Dornier Post* (English Edition), no. 3, 1978, p. 55-57

An experimental helicopter flight control system is briefly described, that has special features such as vertical situation display (VSD), horizontal situation display (HSD), side stick control, artificial sight with FLIR and laser range finder, and helmet-mounted sight with line-of-sight stabilization and pointing. Data are picked up by a microcomputer, processed by the computer, and displayed as an integrated overall situation. Data flows among the microcomputers are clearly structured and channelled. A data channel consists of a single cable. The channels form a central nerve system linking all devices in an integrated system that can be designed redundantly. P T H

A79-20007 Stress intensity factors, for collinear cracks in a stiffened sheet D P Rooke (Royal Aircraft Establishment, Farnborough, Hants, England) and D J Cartwright (Southampton, University, Southampton, England) *International Journal of Fracture*, vol. 14, Oct 1978, p. R237-R240. Research supported by the Ministry of Defence (Procurement Executive)

A common airframe structural element is a large sheet with riveted stiffeners, where cracks initiate at the holes and grow into the sheet at right angles to the main stress direction, which is parallel to the stiffeners. Multiple initiation at different stiffeners can thus

result in an array of collinear cracks. Although the stress intensity factors are known for many configurations with single cracks, they are not known for the stiffened panel with multiple cracks. In this paper, the method of compounding is used to develop stress intensity factors for multiple cracks in stiffened sheets using the known results for single cracks. S D

A79-20016 * # Experimental evaluation of a wind shear alert and energy management display. K-F Kraiss (Forschungsinstitut für Anthropotechnik Meckenheim, West Germany) and D L Baty (NASA, Ames Research Center, Moffett Field, Calif.) *Deutsche Gesellschaft für Luft- und Raumfahrt und Hermann-Oberth-Gesellschaft, Deutscher Luft- und Raumfahrtkongress, Darmstadt, West Germany, Sept 19-23, 1978, DGLR Paper 78-153* 29 p 5 refs

A method is proposed for onboard measurement and display of specific windshear and energy management data derived from an air data computer. An open-loop simulation study is described which was carried out to verify the feasibility of this display concept, and whose results were used as a basis to develop the respective cockpit instrumentation. The task was to fly a three-degree landing approach under various shear conditions with and without specific information on the shear. Improved performance due to augmented cockpit information was observed. Critical shears with increasing tailwinds could be handled more consistently and with less deviation from the glide path. V P

A79-20018 # Fatigue strength of airplanes and modern structural designs (Ermüdungsfestigkeit von Flugzeugen und modernen Bauweisen). G Gruninger (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Stuttgart, West Germany) *Deutsche Gesellschaft für Luft- und Raumfahrt und Hermann-Oberth-Gesellschaft, Deutscher Luft- und Raumfahrtkongress, Darmstadt, West Germany, Sept 19-23, 1978, DGLR Paper 78-176* 49 p 29 refs. In German

The discussion is focused on state-of-the-art methods of improving the fatigue strength of light metal and fiber-reinforced plastic aircraft components. The topics covered include methods of improving the properties of construction materials, the development and testing of novel structural designs and components, methods of manufacturing cost effective, reproducible, and reliable components, improved methods for calculating and testing fatigue life, and methods of predicting fatigue during the design stage, in operation, and in the case of changes in the mode of operation. Current trends in the development of structural designs are examined. V P

A79-20019 # Determination of the fatigue strength of heavily stressed components of the Alpha-Jet (Nachweis der Ermüdungsfestigkeit hochbeanspruchter Komponenten am Alpha Jet). W Uhse (Dornier GmbH, Friedrichshafen, West Germany) *Deutsche Gesellschaft für Luft- und Raumfahrt und Hermann-Oberth-Gesellschaft, Deutscher Luft- und Raumfahrtkongress, Darmstadt, West Germany, Sept 19-23, 1978, DGLR Paper 78-177* 12 p. In German

The paper deals with the military Alpha-Jet multipurpose aircraft, developed in cooperation by Marcel Dassault/Breguet Avion and Dornier. Two engines, with 1345 kgf thrust each, provide a maximal flight Mach number of 0.85. The nominal takeoff weight is 4500 kgf, extendable to 7000 kgf. The safe load factor is approximately 8.6 and the theoretical ultimate load factor is roughly 12. The aircraft is designed for maximum simplicity, reliability, and maintainability. The fatigue tests carried out by the manufacturer and the official acceptance tests are described for both the trainer and combat versions of aircraft. V P

A79-20020 Effect of CFRP technology on structural design and fatigue behavior of modern fighter aircraft (Einfluss der KFK-Technologie auf die konstruktive Auslegung und das Ermüdungsverhalten von modernen Kampfflugzeugen). F J Arendts, W Hartmann, L Lemmer, and K O Sippel (Messerschmitt Bolkow-Blohm GmbH, Ottobrunn, West Germany) *Deutsche Gesellschaft für Luft- und Raumfahrt und Hermann-Oberth-Gesellschaft, Deutscher Luft- und Raumfahrtkongress, Darmstadt, West Germany, Sept 19-23, 1978, DGLR Paper 78-179* 48 p 9 refs. In German (MBB-UF-1444-O)

Attention is called to the fatigue characteristics of carbon-fiber reinforced plastics that must be taken into account in the design of CFRP aircraft components. The discussion covers the influence of tensile and compressive stresses on the fatigue behavior of CFRP, the effect of overloads, truncation and omission on the fatigue behavior of CFRP, and notch effect and yield limit of CFRP. Some design examples are discussed, including the CFRP taileron for the Tornado and a CFRP wing. P T H

A79-20022 Statistical influence of size and configuration (Statistischer Grossen- und Gestaltseinfluss). O Gokgol (Messerschmitt-Bolkow-Blohm GmbH, Ottobrunn, West Germany) *Deutsche Gesellschaft für Luft- und Raumfahrt und Hermann-Oberth-Gesellschaft, Deutscher Luft- und Raumfahrtkongress, Darmstadt, West Germany, Sept 19-23, 1978, DGLR Paper 78-181* 21 p. In German

The lifetime of a structural member subjected to vibratory strain is defined by the material itself, the type and duration of the load, the ambient conditions, and the configuration, size, and number of fatigue prone parts of the structural member. The present lecture deals with theoretical and experimental methods of determining the statistical influence of size and shape on the fatigue strength of notched and unnotched components of a transport aircraft. V P

A79-20025 Thoughts on the future of military aviation I (Gedanken zur Zukunft der militärischen Luftfahrt I). O Friedrich (Messerschmitt Bolkow-Blohm GmbH, Ottobrunn, West Germany) *Deutsche Gesellschaft für Luft- und Raumfahrt und Hermann-Oberth-Gesellschaft, Deutscher Luft- und Raumfahrtkongress, Darmstadt, West Germany, Sept 19-23, 1978, DGLR Paper 78-184* 21 p. In German (MBB UF-1442-O)

The military aviation resources of the NATO countries and of the Warsaw Pact countries are considered, and characteristics of contemporary military aircraft used by NATO countries are described. Major innovations of the past in aircraft design are summarized, and contemporary innovations, in particular the use of carbon fiber-reinforced plastics in aircraft construction, are noted. Procedures for rationalizing and facilitating the development of future military aircraft are suggested. M L

A79-20049 Surface deformations as a runway design criterion. H K Kulshrestha and P S Sandhawalia (International Airport Authority of India, New Delhi, India) *Airport Forum*, vol 8, Dec 1978, p 19, 20, 22-27. In English and German

The surface of a runway takes on a wave profile in the course of time. When the oscillations which this causes in the aircraft exceed a certain level, the runway must be resurfaced. In recognition of this, the International Airports Authority of India has developed and tested a new method of designing pavements, which is presented here. It is based on a mixed fleet of design aircraft. The deformations these will produce in the pavement are computed, and the performance of a runway is related in practice to the jolts which the aircraft experience over the runway life as a result of the wave profile. (Author)

A79-20050 The MLS approach and landing system. R M Cox and E F Kolb (Bendix Corp., Communications Div., Baltimore, Md.) *Airport Forum*, vol 8, Dec 1978, p 53, 55-60, 62. In English and German

The time reference scanning beam (TRSB) system, the micro-wave landing system (MLS) selected to replace the instrument landing system (ILS) is described with emphasis on the differences between MLS and ILS. Reasons for replacing the ILS system are examined, and the MLS adoption procedure and schedule of implementation are considered. The working principle, function, and operation of TRSB are discussed with attention to the relation between ground equipment configuration and TRSB capabilities. M L

A79-20077 # The role of wind tunnels in future aircraft development. /Daniel and Florence Guggenheim International

Memorial Lecture/ R Smelt In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1 Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 110-12 refs

The paper discusses some factors which are expected to change the traditional role of wind tunnels. The growing shortage and cost of petroleum will increase the designer's emphasis on drag reduction, thus reducing his dependence on the wind tunnel for control information. Drag measurement has always been difficult in wind tunnels because of problems with transition and low Reynolds number. Aerodynamic design by computational methods is now able to take over many of the traditional development functions of the wind tunnel. It is suggested that wind tunnels may be relegated to the role of providing data for engineering applications of computers. B J

A79-20078 * # Fuel conservative aircraft engine technology D L Nored (NASA, Lewis Research Center, Cleveland, Ohio) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1 Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 11-26-22 refs

NASA's Aircraft Energy Efficiency Program, initiated in an effort to minimize the adverse impact of the worldwide fuel crisis, will develop technology for more fuel-efficient subsonic transport aircraft. The program includes three major propulsion projects: (1) Engine Component Improvement, directed at current engines, (2) Energy Efficient Engine, directed at new turbofan engines, and (3) Advanced Turboprops, directed at technology for advanced turboprop-powered aircraft. The present paper reviews the current status of each of these projects and describes some of the technologies and recent accomplishments. B J

A79-20079 # Prediction methods in aeroelasticity (Les méthodes de prévision en aéroélasticité) R Dat (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1 Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 27-41-40 refs. In French (ONERA, TP no 1978-49)

A number of aeroelastic phenomena are reviewed including wing flutter, compressor blade cascade instabilities, aeroelastic vibrations of nonstreamlined structures, and aeroelastic phenomena peculiar to rotary wings. Coupling mechanisms responsible for the instabilities are discussed and attention is given to methods for predicting aeroelastic phenomena. Linear methods of prediction are found to be inadequate for problems of unsteady aerodynamics. New methods for solving the nonlinear potential equation are discussed. B J

A79-20080 # A comprehensive review of airframe noise research H H Heller and W M Dobrzynski (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Abteilung Technische Akustik, Braunschweig, West Germany) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1 Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 42-60-49 refs

The paper discusses the development of airframe noise research and its present state of the art. Such approaches to noise prediction as the total-aircraft method and the aircraft-component method are discussed, with emphasis on the examination of wing trailing edge sources and landing gear/wheel-well sources as the prime contributors to airframe noise. Theoretical and experimental results are presented, and some airframe noise reduction concepts are examined. B J

A79-20081 The evolution of fly-by-wire control techniques in the UK G H Hunt (Royal Aircraft Establishment, Farnborough, Hants, England) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September

10-16, 1978, Proceedings Volume 1 Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 61-71-8 refs

A research program, including theoretical studies and flight tests, has been conducted in the United Kingdom with the aim of producing high-integrity fly-by-wire (FBW) control systems with acceptably low overall cost penalties. This has led to the fitting of a full-time multiplex digital control system to a Jaguar aircraft. Some of the design benefits of FBW are reviewed including artificial longitudinal stability, automatic configuration management, maneuver load control, direct force control, ride control, flutter control, and miniature stick control. B J

A79-20082 # Benefits of spanwise blowing at transonic speeds C J Dixon, T Dansby (Lockheed-Georgia Co., Marietta, Ga.), and P Poisson-Quinton (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1 Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 72-84-13 refs (ONERA, TP no 1978-98)

An exploratory investigation was performed in a blowdown wind tunnel in an attempt to demonstrate the beneficial effects of spanwise blowing at transonic speeds. Spanwise directed nozzles located on the wing model provided control of the shock-induced separation which occurred at Mach 0.9. Blowing momentum coefficients of less than 0.005 produced significantly improved longitudinal aerodynamic characteristics at attitudes where shock-induced separation predominated. Such benefits were exemplified by a 16 percent improvement in the lift coefficient for axial force break afforded by a modest blowing level (0.002). A multicolor flow visualization technique was used to study the nature of the flow separation and the control afforded by spanwise blowing. B J

A79-20083 # Effect of spanwise blowing in the angle-of-attack regime $\alpha = 0^\circ$ to 90° W Staudacher (Messerschmitt-Bölkow-Blohm GmbH, Munich, West Germany), B Laschka (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany), P Poisson-Quinton (ONERA, Paris, France), and J P Ledy (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1 Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 85-95-34 refs. Research supported by the Bundesministerium der Verteidigung (ONERA, TP no 1978-80)

Wind tunnel tests were conducted to investigate the possible benefits of spanwise blowing at subsonic speeds and high angles of attack, benefits relating to stability and control and high lift performance were investigated for a basic fighter model. In the first stage of testing, the position of the blowing jet was optimized relative to the wing upper surface for such configurations as clean wing, strake wing, and high lift configuration. In the second stage the angle of attack range investigated was extended up to 90° for the selected strake wing configuration. Results show that concentrated spanwise blowing is a simple means to increase maneuver performances at high angle of attack. B J

A79-20084 # Drag reduction by cooling in hydrogen fueled aircraft E Reshotko (Case Western Reserve University, Cleveland, Ohio) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1 Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 96-106-25 refs

Drag reductions are possible for cryo-fueled aircraft by using the fuel to cool selected aerodynamic surfaces on its way to the engines. This is because cooled laminar boundary layers in air at subsonic and low supersonic speeds are more stable than adiabatic boundary layers and therefore more resistant to transition to turbulent flow. Calculations for a $M = 0.85$ hydrogen-fueled transport show that drag reductions in cruise of about 20% are within reason. The weight of the fuel saved is well in excess of the weight of the required cooling.

system. These results suggest that the hydrogen-fueled aircraft employing surface cooling is quite attractive as an energy conservative aircraft and warrants more detailed study (Author)

A79-20087 * # Recent advances in convectively cooled engine and airframe structures for hypersonic flight H N Kelly, A R Wieting, C P Shore, and R J Nowak (NASA, Langley Research Center, Hampton, Va.) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1 Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 137-151 31 refs

Research over the past decade has identified critical thermal/structural design problems and has produced viable design concepts for a second generation experimental scramjet. The design concepts for the hydrogen fuel-cooled engine structure involve a variety of innovative features to accommodate the harsh aerothermal environment encountered within the engine. The baseline concept which has evolved has reasonable mass characteristics, and cooling requirements which permit engine operation to Mach 9.10 without additional hydrogen for engine cooling. Studies have identified fabrication techniques and coolant passage configurations that increase fatigue life of the structure an order of magnitude over previous configurations B J

A79-20088 # On the aerodynamics of hypersonic cruise vehicles at off-design conditions U Ganzer, H Hoder, and J Szodrach (Berlin, Technische Universität, Berlin, West Germany) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1

Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 152-161 11 refs

A survey is presented concerning aerodynamic research work carried out at the Technical University of Berlin. The experimental work dealt with the leeside flow past delta wings with sharp leading edges at supersonic speeds and various angles of attack and with the flow field of two waverider-configurations (Nonweiler and Jones) at subsonic and low supersonic speeds. The theoretical work was concerned with shock induced separations on the leeside of delta wings, with the flow along the lower surface of a Nonweiler wing with attached shock and with the flow around bodies of general shape under conditions justifying the slender-body approximation (Author)

A79-20089 # Jet flow interactions G F Marsters (Queen's University, Kingston, Ontario, Canada) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1 Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 162-172 19 refs. National Research Council of Canada Grant No. A 4310

In the design of powered lift devices for STOL aircraft, frequent use is made of jet flows which interact with solid surfaces, e.g., in upper surface blowing, blown flaps and especially in lift/thrust augmenting devices. This paper discusses several configurations which involve the interaction of ventilated jets with nearby walls and the effects of nozzle cross-sectional shape on jet mixing. Some of the results from these studies may also be relevant to the problems of disposal of pollutants (Author)

A79-20092 # Recent developments in helicopter noise reduction H Sternfeld, Jr (Boeing Vertol Co., Philadelphia, Pa.) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1 Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 190-198 11 refs

This paper reports on research activities directed at understanding and reducing interior and exterior noise of modern helicopters. Impending regulatory criteria for external noise are discussed, along with some of the newer understandings of the sources of rotor noise. The effect of rotor design on generated noise

and methods for reducing the noise are presented. The paper also explains the application of finite element analytical techniques to optimizing the dynamic response of helicopter transmissions in order to minimize interior noise (Author)

A79-20099 * # Application of computational aerodynamics methods to the design and analysis of transport aircraft A L da Costa (Boeing Commercial Airplane Co., Seattle, Wash.) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1 Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 261-269 27 refs. NASA-supported research

The application and validation of several computational aerodynamic methods in the design and analysis of transport aircraft is established. An assessment is made concerning more recently developed methods that solve three-dimensional transonic flow and boundary layers on wings. Capabilities of subsonic aerodynamic methods are demonstrated by several design and analysis efforts. Among the examples cited are the B747 Space Shuttle Carrier Aircraft analysis, nacelle integration for transport aircraft, and winglet optimization. The accuracy and applicability of a new three-dimensional viscous transonic method is demonstrated by comparison of computed results to experimental data (Author)

A79-20100 # Recent applications of advanced computational methods in the aerodynamic design of transport aircraft configurations F T Lynch (Douglas Aircraft Co., Long Beach, Calif.)

In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1 Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 270-284 17 refs

A new, improved version of the Cebeci-Kaups-Ramsey (CKR) three-dimensional finite-difference boundary layer program for arbitrary wings has been coupled with the Jameson-Caughey full potential transonic flow method in order to predict the combined viscous/inviscid flow characteristics of three-dimensional swept wings at transonic conditions. Some preliminary computed results are presented for two advanced transport wing configurations. The calculated three-dimensional results are compared with experimental results and with calculations obtained by using the two-dimensional strip-theory approximation. Limitations of the current method and areas requiring further study are discussed (Author)

A79-20101 # Numerical study of the supersonic flow around wings G P Voskresenskiy (Akademiya Nauk SSSR, Institut Prikladnoi Matematiki, Moscow, USSR) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1

Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 285-291 8 refs

The paper deals with the application of finite-difference algorithms, developed for solving problems for nonlinear gasdynamics equations, to the calculation of supersonic flows past flat wings of various planform with and without flaps. Flow fields calculated for wings of identical planform but different flaps and different positions of the bow shock wave are examined, along with flow fields at the upper side of delta wings with and without flaps, and flow fields about elliptical wings. The lift coefficients of delta wings are calculated within the framework of linear theory V P

A79-20102 # Investigation of the transonic drag characteristics for non-slender wing-body combinations and their equivalent axisymmetric bodies at zero lift N Agrell, R Mattsson, and S-E Nyberg (Flygtekniska Forsöksanstalten, Bromma, Sweden) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1 Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 292-304 21 refs. Defence Materiel Administration of Sweden Contract No. AU-1213

A theoretical and experimental investigation was conducted to explore the applicability of the transonic similarity concept and also of the transonic area rule for non-slender wing-body combinations. A family of eight wing-body combinations (wing aspect ratios 3-5) and their equivalent axisymmetric bodies were investigated at zero lift. The transonic drag was determined by wind tunnel tests and by theoretical calculations using a transonic small disturbance method. The theoretical and experimental results for these non-slender configurations deviated from the transonic area rule as the span increased, but confirmed the transonic similarity concept. (Author)

A79-20105 # Evaluation and analysis of computations and experiments for transonic wing body configurations G Drougge, N Agrell, S Hedman, and L Torngren (Flygtekniska Forsöksanstalten, Bromma, Sweden). In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1. Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 325-332. 9 refs. Defence Materiel Administration of Sweden Contract No AU-1418.

Based on transonic small perturbation theory, the method proposed can be used, in the direct mode, to calculate the transonic drag characteristics of a configuration beyond the design point. In the inverse mode, the method is well suited for designing wing body configurations. The calculated pressure distributions were found to be in reasonable agreement with the results of verification experiments. V P

A79-20106 # Calculation of the non linear aerodynamic coefficients of wings of various shapes and their wakes, including canard configurations J Rom, C Zorea (Technion - Israel Institute of Technology, Haifa, Israel), and D Almosnino. In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1.

Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 333-344. 20 refs.

A method is proposed for calculating the nonlinear longitudinal aerodynamic characteristics of such planar configurations as multiple lifting surfaces in subsonic flow at large angles of attack. The highly satisfactory results obtained for strong interactions and nonlinear effects seem to justify the effort of extending the method to the design and analysis of configurations which include body and thickness effects. The method is well suited for analyzing aerodynamic characteristics up to angles of attack at which stall and vortex breakdown phenomena set in. V P

A79-20107 # Separated and unsteady flows in aeronautics - Research at the University of Bristol J W Flower and A Simpson (Bristol, University, Bristol, England). In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1.

Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 345-354. 14 refs.

It is tried to indicate the increasingly wide range of separated and unsteady flow problems occurring in aeronautics. Attention is given to steady separated flows around fixed shapes, flow instabilities for fixed shapes, quasi steady flows, dynamic effects for rigid shapes, dynamic effects for elastic bodies, dynamic effects for rapidly changing shapes, a nonuniform approaching stream, and separated and unsteady flow problems relating to the power unit. It is pointed out that experiment is essential because the field is very complex and theory cannot supply the answers. However, too much ad hoc testing can be very wasteful. The mathematical approach is also of great use but again, much time can be wasted. The best approach would, therefore, appear to be an appropriate combination of both theory and experiment. G R

A79-20108 # Development of a low-correction wind tunnel wall configuration for testing high lift airfoils G V Parkinson (British Columbia, University, Vancouver, Canada), C D Williams (National Aeronautical Establishment, Ottawa, Canada), and A

Malek. In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1.

Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 355-360. 6 refs. National Research Council of Canada Grant No A-586.

A recent innovation in wind tunnel test section design intended to reduce wall corrections in high-lift airfoil testing to negligible values is described. The test-section wall opposite the pressure side of the test airfoil is solid as in conventional tunnels, but the wall opposite the suction side consists of uniformly spaced transverse slats of symmetrical airfoil profile. This configuration permits the streamline pattern near the test airfoil to approach free-air conditions, so that the loading on the airfoil approaches its free air values. Parameters for the wall configuration are chosen on the basis of potential-flow modeling, and some of the theoretical predictions and experimental comparisons are presented in the paper. The results are encouraging. (Author)

A79-20109 # The application of winglets to rotors T van Holten (Delft, Technische Hogeschool, Eindhoven, Netherlands). In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1.

Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 361-369.

The paper deals with preliminary results of theoretical and experimental research on tipvanes as a means of providing large mass flow augmentation through rotors in a manner comparable to a duct (about the rotor). The amount of augmentation can be estimated roughly from a relatively simple theory that has been verified experimentally. Whether tipvanes will prove important in actual applications will depend largely on the power lost to overcome their drag as compared with the power saved by mass-induction effects. Theoretical and experimental studies point to a small value of the induced drag of tipvanes. As in the case of ducts, almost no vorticity is left in the flow. On the other hand, optimization of the profile drag of tipvanes is complicated by boundary layer anomalies which may be attributed to rotational effects. V P

A79-20110 * # Scale effects on supercritical airfoils J A Blackwell, Jr (Lockheed Georgia Co., Marietta, Ga). In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1.

Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 370-383. 8 refs. Contract No NAS1 12325.

A survey of research relative to scale effects on supercritical airfoils has been conducted. The results of this survey indicated that Reynolds number scale effects have a significant impact on airfoil design and performance. Further, this impact is greater for supercritical airfoils than for conventional airfoils. It was found that low Reynolds number drag data could be extrapolated to high Reynolds number conditions provided the flow was attached and the pressure distribution shape did not change appreciably. Airfoil lift and pitching-moment data obtained at low Reynolds numbers cannot be extrapolated to full-scale values. Viscous theoretical transonic analysis methods currently under development will significantly improve the ability of the designer to account for scale effects. Boundary layer manipulation in low Reynolds number facilities using natural transition or aft located transition strips to simulate high Reynolds number conditions was shown to be an uncertain test procedure and *reliance should be made on high Reynolds number facilities if available*. (Author)

A79-20111 * # Aeronautical test facilities capabilities and use J S Kamchi (USAF, Washington, D C) and F E Compitello (NASA, Washington, D C). In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1.

Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 384-394. 15 refs.

In the present paper, the status and technical capabilities of the National Aeronautical Facility Program and several support facilities

for future aeronautical RDT&E are briefly reviewed. It is seen that these facilities deserve support by government and industry, since aeronautical technology will be constantly required to resolve uncertainties arising in new designs, new materials, and new synthetic fuel systems V P

A79-20112 # The pressurized subsonic wind tunnel, F1, at ONERA's Fauga-Mauzac Center (Soufflerie subsonique pressurisée F1 du Centre du Fauga-Mauzac de l'ONERA) M Pierre (ONERA, Châtillon sous Bagneux, Hauts-de-Seine, France) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1

Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 395-416 In French (ONERA, TP no 1978-51)

With a test section of 4.50 by 3.50 m and the capability of varying the pressure from 1 to 4 bar, the tunnel described provides a means of studying lift phenomena on aircraft wings at Reynolds numbers up to 6,000,000 and high subsonic Mach numbers. By varying the pressure, the influence of the Reynolds number can be studied without varying the velocity. A distinctive feature of the facility is the convenience provided by easily exchangeable models, each equipped with its own measuring system V P

A79-20113 The RAE 5 metre pressurised low speed wind tunnel A Spence, D S Woodward, M T Cager, A J Sadler, and R W Jeffery (Royal Aircraft Establishment, Farnborough, Hants, England) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1

Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 417-431 5 refs

The 5-m pressurized low-speed wind tunnel discussed in the present paper is expected to be an important tool in research and development of stalling and high-lift devices and studying low-speed aerodynamics. It will facilitate the design of aircraft with better low speed performance and with less risk of expensive modification at the flight test stage. The tunnel and its systems for model support, model exchange, tunnel control, and data handling are described, and some results of commissioning and calibration are examined V P

A79-20114 Advances in aeroacoustic windtunnel testing techniques for aircraft noise research J Williams and T A Holbeche (Royal Aircraft Establishment, Farnborough, Hants, England) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1

Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 432-448 10 refs

Acoustic windtunnels with models mounted in a quiet test-section airstream surrounded by an anechoic working chamber have now been established as primary tools for aircraft noise research work, and should be exploited for the direct support of specific quiet aircraft projects. During the past five years, the major problem areas associated with tunnel design and application for noise-model testing at subsonic speeds have been greatly clarified. Here, the special aeroacoustic techniques and limitations required are analyzed and quantified, including tunnel test section demands, tunnel-circuit and airflow-drive design, experimental measurement and analysis techniques, and engine/airframe noise simulation at model-scale. The discussion is based mainly on RAF experience in aeroacoustic testing techniques, particularly with reference to the development and exploitation of the 24 ft anechoic tunnel (7.3 m diam) and the new 1.5 m acoustic tunnel, while naturally taking into account known experimental and theoretical developments elsewhere (Author)

A79-20115 # The German-Dutch wind tunnel DNW - Design aspects and status of construction F Jaarsma and M Seidel (Duits Nederlandse Windtunnel, Noordoostpolder, Netherlands) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1

Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 449-460 8 refs

As a cooperative project of DFVLR and NLR the German-Dutch wind tunnel DNW is under construction in the Noordoostpolder, The Netherlands. The DNW will belong to the largest and most efficient low-speed wind tunnels in Europe and contribute to aircraft development work. Typical design features are closed and cooled circuit, three interchangeable atmospheric test sections with cross sections of 9.5 m x 9.5 m, 8 m x 6 m and 6 m x 6 m with maximum air speeds of 62, 110 and 145 m/s, air exchange system. The equipment includes model sting support, external balance, computers for data handling and controls, compressed air plant, moving belt ground plane, q-stopper, and scoop for hot gas removal. The DNW will cover a wide range of testing capabilities including aeroacoustic (open test section) and testing with real engines. This paper specially refers to overall and aerodynamic design aspects and the development of selected components (Author)

A79-20116 # An intermittent high Reynolds number wind tunnel J L Stollery (Cranfield Institute of Technology, Cranfield, Beds, England) and A V Murthy (National Aeronautical Laboratory, Bangalore, India) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1

Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 461-465

The paper suggests a simple method of generating intermittent reservoir conditions for an intermittent, cryogenic wind tunnel. This can be done by operating some existing types of short-duration tunnels 'in reverse'. Two examples are considered: (1) a modification of the Ludwig Tube and (2) the Isentropic Light Piston Tunnel. The sizes of tunnels required to meet the European and American specifications for a high Reynolds number tunnel with a 10 second running time are given together with proposals for a more modest national or university facility with a one second test time (Author)

A79-20117 # Problems raised by the application of the natural stability reduction concept to transport aircraft C Pelagatti, M Bossard, and J Irvoas (Société Nationale Industrielle Aérospatiale, Toulouse, France) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1

Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 466-474

The paper deals with some problems associated with the concept of improving aircraft performance by reducing stability. Specifically examined are problems which arise in the design of flight controls, main landing gear, and control surfaces. The supersonic transport aircraft, Concorde, is taken as an example to show how problems concerning flight controls could be resolved by the use of fly-by-wire controls. In the case of subsonic aircraft, however, it is deemed necessary to keep a certain number of mechanical controls as an emergency facility. It is shown that technological progress made in the field of fly-by-wire controls must be accompanied by parallel efforts in the field of aerodynamic and structural design in order to maximize the benefit obtainable from the reduced stability concept V P

A79-20118 # Evaluation of a method to extract performance data from dynamic maneuvers for a jet transport aircraft J H Breeman and J L Simons (Nationaal Lucht en Ruimtevaartlaboratorium, Amsterdam, Netherlands) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1

Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 475-488 18 refs

In the study described, the accuracy of a method for determining jet-aircraft performance characteristics and stability derivatives from a single dynamic maneuver was evaluated using a program developed for the Fokker F 28 Fellowship aircraft. Preliminary test

data, based on lift-drag polars, show excellent agreement with data obtained by the conventional steady-state test technique. A highly accurate air-data measurement system used in the test program is described. V P

A79-20119 # Crack free and cracked life of the pressurized cabin of the A 300 B - Calculation, tests and design measurements to improve damage tolerance O Gokgol (Messerschmitt Bolkow-Blohm GmbH, Hamburg, West Germany) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1 Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 489-504 10 refs

In the study described, experience acquired in designing and constructing Caravelle and Trident aircraft was used in combination with a test program in an attempt to ensure the reliability of the Airbus A 300 B fuselage. The methods used to calculate the stress distribution within the structure are outlined, along with the methods of evaluating the residual strength and methods of damage tolerant design. Full-scale fatigue tests and test programs developed for optimizing parts and subassemblies are discussed. It was found that cracks which form at fitting runouts (last riveted row) propagate much faster than in the case of a continuous riveting. This phenomenon is attributed to the influence of the stiffener on stress intensity. The study indicates that service life can be increased either by improving the fatigue strength of the last rivet row or by using softer rivets (with a rivet head height of 1.0 to 1.1 mm). V P

A79-20121 # Research conducted by ONERA on the relationship between the behavior and cumulative damage of materials and structures (Recherches de l'ONERA sur le couplage entre le comportement et l'endommagement des matériaux et structures) R Labourdette (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1 Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 518-543 46 refs In French (ONERA, TP no 1978-50)

The present synthesis of research work is focused on two areas - the viscoelastoplastic behavior under mechanical and thermomechanical loads and small-scale yielding. A method of predicting creep and fatigue damage cumulation is described and its effectiveness is substantiated by a comparison with test results obtained for turbine blades. In the case of small-scale yielding, algorithms for calculating stress intensity factors are outlined, and a model of fatigue crack growth under loads of variable amplitude is examined. V P

A79-20122 # Fracture toughness of multiply layer adhesive bonded aluminum alloy sheet P F A Bijlmer (Fokker-VFW, Amsterdam, Netherlands) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1 Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 544-554 6 refs

In the present paper, the fracture toughness of multiply adhesive bonded (MAB) and solid specimens prepared of various aluminum alloys was studied and compared. It is shown that the fracture toughness of MAB sheet is superior and that the relative increase in fracture toughness of MAB materials higher for materials of low fracture toughness. The relative improvement due to reinforcing the adhesive layer is practically the same for low- and high-fracture toughness materials. The data obtained for the individual alloys are tabulated. V P

A79-20128 * # Flutter suppression and gust alleviation using active controls - Review of developments and applications based on the aerodynamic energy concept E Nissim (Technion - Israel Institute of Technology, Haifa, Israel) In International Council of the Aeronautical Sciences, Congress, 11th, Lisbon, Portugal, September 10-16, 1978, Proceedings Volume 1

Cologne, International Council of the Aeronautical Sciences Secretariat (DGLR), 1978, p 600-615 31 refs NASA-supported research

The state of the art of the aerodynamic energy concept, involving the use of active controls for flutter suppression, is reviewed. Applications of the concept include the suppression of external-store flutter of three different configurations of the YF-17 flutter model using a single trailing edge control surface activated by a single fixed-gain control law. Consideration is also given to some initial results concerning the flutter suppression of the 1/20 scale low speed wind-tunnel model of the Boeing 2707 300 supersonic transport using an activated trailing edge control surface. B J

A79-20206 Transformation of coordinates associated with linearized supersonic motions T S Shankara and K K Nandi (Indian Institute of Technology, Madras, India) *Journal of Applied Physics*, vol 49, Dec 1978, p 5783-5789 19 refs

A Lorentz like transformation (LLT) is introduced in the supersonic regime which keeps the wave equation invariant and simultaneously fixes the coordinate system to the body, producing small disturbances. Its implications, which appear to be far reaching, are briefly discussed. (Author)

A79-20230 Wide-aperture digital VOR A S Palatnick (Cutler-Hammer, Inc., AIL Div., Deer Park, N Y) *IEEE Transactions on Aerospace and Electronic Systems*, vol AES-14, Nov 1978, p 853-865 10 refs U.S. Department of Transportation Contract No FA73WA-3169

The wide-aperture digital VOR design is based on the crossed-pair interferometer principle where eight such pairs are energized successively by a set of pulses and phase shifts. The time multiplexed signal, detected by the aircraft receiver, is processed and simple digital computations are performed to determine the angular coordinates. Performance improvements over present VOR have been achieved by the use of a 275-ft antenna and the use of digital techniques to generate the ground radiated navigational signals and process them in the airborne processor. Field tests of the feasibility model indicate it is a high performance system, capable of achieving an order of magnitude improvement in both site error reduction and accuracy over present VOR systems. B J

A79-20232 The ILS glidepath - New designs for severe sites J G Lucas and A C Young (Sydney, University, Sydney, Australia) *IEEE Transactions on Aerospace and Electronic Systems*, vol AES 14, Nov 1978, p 873-883 12 refs Research supported by the Department of Transportation of Australia

A fundamental new theory for the operation of the instrument landing system (ILS) glidepath is presented. Simple new image array designs for use on severe sites are developed from this theory. The new arrays have been thoroughly tested at model scale and on a particularly severe site at Sydney airport. The approach also leads to a simpler setting up procedure which substantially improves performance. (Author)

STAR ENTRIES

N79-14011*# National Aeronautics and Space Administration
Ames Research Center Moffett Field Calif

AIRFOIL DESIGN BY NUMERICAL OPTIMIZATION USING A MINICOMPUTER

Raymond M Hicks and C A Szelazek (Computer Information Systems Cupertino Calif) Dec 1978 28 p refs
(NASA-TM-78502 A-7505) Avail NTIS HC A03/MF A01 CSCL 01A

A computer program developed for the automated design of low speed airfoils utilizes a generalized Joukowski method for aerodynamic analysis coupled with a conjugate gradient penalty function numerical optimization algorithm to give an efficient calculation technique for use with minicomputers. The program designs airfoils with a prescribed pressure distribution as well as those which minimize or maximize some aerodynamic force coefficient. At present the method is restricted to inviscid incompressible flow. A typical design problem will execute in 45 hr on an HP 9830 minicomputer. A R H

N79-14012*# National Aeronautics and Space Administration
Langley Research Center Hampton Va

EFFECT OF AN ALTERNATE WINGLET ON THE PRESSURE AND SPANWISE LOAD DISTRIBUTIONS OF A FIRST GENERATION JET TRANSPORT WING

Lawrence C Montoya (NASA Dryden Flight Research Center), Stuart G Flechner, and Peter F Jacobs Dec 1978 95 p refs
(NASA-TM-78786 L-12519) Avail NTIS HC A05/MF A01 CSCL 01A

Pressure and spanwise load distributions on a first-generation jet transport semispan model at subsonic speeds are presented. The wind tunnel data were measured for the wing with and without an alternate winglet. The results show that the winglet affected outboard wing pressure distributions and increased the spanwise loads near the tip. Author

N79-14013*# National Aeronautics and Space Administration
Langley Research Center Hampton Va

EFFECT OF CANARD VERTICAL LOCATION, SIZE, AND DEFLECTION ON CANARD-WING INTERFERENCE AT SUBSONIC SPEEDS

Blair B Gloss Edward J Ray and Karen E Washburn Dec 1978 120 p refs
(NASA-TM-78790, L-12523) Avail NTIS HC A06/MF A01 CSCL 01A

A generalized close-coupled canard-wing configuration was tested in a high speed 7 by 10 foot tunnel at Mach numbers of 0.40, 0.70, and 0.85 over an angle-of-attack range from -4 deg to 24 deg. Studies were made to determine the effects of canard vertical location, size, and deflection and wing leading-edge sweep on the longitudinal characteristics of the basic configuration. The two wings tested had thin symmetrical circular-arc airfoil sections with characteristically sharp leading edges swept at 60 deg and 44 deg. Two balances which allow separation of the canard-forebody contribution from the total forces and moments were used in this study. G G

N79-14015*# National Aeronautics and Space Administration
Langley Research Center Hampton, Va

INITIAL FEASIBILITY STUDY OF A MICROWAVE-POWERED SAILPLANE AS A HIGH-ALTITUDE OBSERVATION PLATFORM

Harry H Heyson Dec 1978 17 p refs
(NASA-TM-78809) Avail NTIS HC A02/MF A01 CSCL 01C

It is shown that a microwave-powered sailplane can be a reasonable substitute for a satellite in some missions requiring

only limited coverage of the surface of the earth. A mode of operation in which the aircraft cyclically climbs to high altitude in the beam and then glides for several hundred kilometers is feasible and takes advantage of the inherent forward speed of the sailplane at high altitude. G G

N79-14016*# McDonnell Aircraft Co., St. Louis Mo **FEASIBILITY OF COMBINING LINEAR THEORY AND IMPACT THEORY METHODS FOR THE ANALYSIS AND DESIGN OF HIGH SPEED CONFIGURATIONS**

Final Report

D Brooke and D V Vondrasek Dec 1978 42 p refs

(Contract NAS1-15074)

(NASA-CR-3069) Avail NTIS HC A03/MF A01 CSCL 01A

The aerodynamic influence coefficients calculated using an existing linear theory program were used to modify the pressures calculated using impact theory. Application of the combined approach to several wing-alone configurations shows that the combined approach gives improved predictions of the local pressure and loadings over either linear theory alone or impact theory alone. The approach not only removes most of the short-comings of the individual methods as applied in the Mach 4 to 8 range but also provides the basis for an inverse design procedure applicable to high speed configurations. G Y

N79-14018*# National Aeronautics and Space Administration
Langley Research Center Hampton, Va

LOW-SPEED AERODYNAMIC CHARACTERISTICS OF A 16-PERCENT-THICK VARIABLE-GEOMETRY AIRFOIL DESIGNED FOR GENERAL AVIATION APPLICATIONS

Richard W Barnwell, Kevin W Noonan and Robert J McGhee Dec 1978 77 p refs. Prepared in cooperation with Army Aviation Research and Development Command, St. Louis, Mo (DA Proj 1L1-61102-AH-45)

(NASA-TP-1324 AVRADCOM-TR-78-45) Avail NTIS HC A05/MF A01 CSCL 01A

Tests were conducted in the Langley low-turbulence pressure tunnel to determine the aerodynamic characteristics of climb, cruise, and landing configurations. These tests were conducted over a Mach number range from 0.10 to 0.35, a chord Reynolds number range from 2.0 x 10⁶ to 2.00 x 10⁶, and an angle-of-attack range from -8 deg to 20 deg. Results show that the maximum section lift coefficients increased in the Reynolds number range from 2.0 x 10⁶ to 9.0 x 10⁶ and reached values of approximately 2.1, 1.8, and 1.5 for the landing, climb, and cruise configurations respectively. Stall characteristics, although of the trailing-edge type, were abrupt. The section lift-drag ratio of the climb configuration with fixed transition near the leading edge was about 78 at a lift coefficient of 0.9, a Mach number of 0.15, and a Reynolds number of 4.0 x 10⁶. Design lift coefficients of 0.9 and 0.4 for the climb and cruise configurations were obtained at the same angle of attack, about 6 deg, as intended. Good agreement was obtained between experimental results and the predictions of a viscous, attached-flow theoretical method. S E S

N79-14019*# National Aeronautics and Space Administration
Langley Research Center, Hampton Va

A LASER VELOCIMETER FLOW SURVEY ABOVE A STALLED WING

Warren H Young Jr., James F Meyers, and Danny R Hoad Dec 1978 138 p refs. Prepared in cooperation with Army Aviation Research and Development Command, St. Louis, Mo (DA Proj 1L1-61102-AH-45)

(NASA-TP-1266 AVRADCOM-TR-78-50) Avail NTIS HC A07/MF A01 CSCL 01A

A laser velocimeter operating in the backscatter mode was used to survey the flow about a stalled wing installed in the Langley V/STOL tunnel. Mean velocities and magnitudes of velocity fluctuations were calculated from measurements of two orthogonal components of velocity. Free shear mixing layers above and below a large separated flow region were defined. Velocity power spectra were calculated at two points in the flow field. The flow-field survey was carried out about a rectangular aspect-ratio-8 wing with an airfoil section. The wing angle of

attack was 19.4 deg the Mach number was 0.148 and the nominal Reynolds number was 1×10^6 Author

N79-14022* National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif

VORTEX EFFECTS FOR CANARD-WING CONFIGURATIONS AT HIGH ANGLES OF ATTACK IN SUBSONIC FLOW

B M E deSilva and R T Medan Dec 1978 32 p refs (NASA-TM-78543 A-7677) Avail NTIS HC A03/MF A01 CSCL 01A

A fully three-dimensional subsonic panel method that can handle arbitrary shed vortex wakes is used to compute the nonlinear forces and moments on simple canard-wing configurations. The lifting surfaces and wakes are represented by doublet panels. The Mangler-Smith theory is used to provide an initial estimate for the vortex sheet shed from the leading edge. The trailing-edge wake and the leading-edge wake downstream of the trailing edge are assumed to be straight and leave the trailing edge at an angle of $\alpha/2$. Results indicate good agreement with experimental data up to 40 degs angle of attack. Author

N79-14023* National Aeronautics and Space Administration Langley Research Center, Hampton, Va

THEORETICAL EVALUATION OF HIGH-SPEED AERODYNAMICS FOR ARROW-WING CONFIGURATIONS

Samuel M Dollyhigh Jan 1979 67 p refs (NASA-TP-1358 L-12485) Avail NTIS HC A04/MF A01 CSCL 01A

The use of the theoretical methods to calculate the high-speed aerodynamic characteristics of arrow-wing supersonic cruise configurations was studied. Included are correlations of theoretical predictions with wind-tunnel data at Mach numbers from 0.8 to 2.7, examples of the use of theoretical methods to extrapolate the wind-tunnel data to full-scale flight condition and presentation of a typical supersonic data package for an advanced supersonic transport application. A brief description of the methods and their application is given. G G

N79-14024* National Aeronautics and Space Administration Ames Research Center, Moffett Field, Calif

EFFECTS OF UPPER SURFACE MODIFICATION ON THE AERODYNAMIC CHARACTERISTICS OF THE NACA 63 SUB 2-215 AIRFOIL SECTION

Raymond M Hicks and Edward T Schairer Jan 1979 27 p refs (NASA-TM-78503, A-7507) Avail NTIS HC A03/MF A01 CSCL 01A

An upper surface modification designed to increase the maximum lift coefficient of a 63 sub 2 - 215 airfoil section was tested at Mach numbers of 0.2, 0.3, and 0.4. Reynolds numbers of 1.3×10^6 , 2×10^6 sub 6 and 2.5×10^6 . Comparisons of the aerodynamic coefficients before and after the modification were made. The upper surface modification increased the maximum lift coefficient of the airfoil significantly at all conditions. G G

N79-14025* National Aeronautics and Space Administration Langley Research Center, Hampton, Va

AERODYNAMIC CHARACTERISTICS OF A SUPERSONIC CRUISE AIRPLANE CONFIGURATION AT MACH NUMBERS OF 2.30, 2.96, AND 3.30

Barrett L Shrout and Roger H Fournier Jan 1979 143 p refs (NASA-TM-78792, L-12570) Avail NTIS HC A07/MF A01 CSCL 01A

An investigation was made in the Langley Unitary Plan wind tunnel at Mach numbers of 2.30, 2.96, and 3.30 to determine the static longitudinal and lateral aerodynamic characteristics of a model of a supersonic cruise airplane. The configuration, with a design Mach number of 3.0, has a highly swept arrow wing with tip panels of lesser sweep, a fuselage chine, outboard vertical tails, and outboard engines mounted in nacelles beneath the wings. For wind tunnel test conditions, a trimmed value above 6.0 of the maximum lift-drag ratio was obtained at the design Mach number. The configuration was statically stable both longitudinally and laterally. Data are presented for variations of

vertical-tail roll-out and toe-in and for various combinations of components. Some roll control data are shown as are data for the various sand grit sizes used in fixing the boundary layer transition location. Author

N79-14026* Lockheed Missiles and Space Co., Huntsville, Ala. Research and Engineering Center

AIRCRAFT WAKE VORTEX CHARACTERISTICS FROM DATA MEASURED AT JOHN F. KENNEDY INTERNATIONAL AIRPORT. Final Report, Jun 1975 - Jun 1977

W R Eberle, M R Brashears, A D Zalay, K R Shrider, and D A Love Mar 1978 254 p refs (Contract DOT-TSC-1023) (AD-A055059, LMSC-HREC-TR-D568181, FAA-RD-78-47, FAA-78-5) Avail NTIS HC A12/MF A01 CSCL 20/4

Data from 1320 aircraft flybys at Kennedy International Airport, Jamaica, New York, in 1975 were processed and stored in a computerized vortex data management system. The data were selectively recalled to determine vortex characteristics pertinent to the design of an effective wake vortex avoidance system. Vortex and meteorological characteristics which are relevant to the design of an effective wake vortex avoidance system are discussed from an analytical viewpoint as well as from an analysis of the data. Several formulations for feedback of vortex sensor information to provide vortex prediction are presented. Several wake vortex avoidance system designs are shown. Author (GRA)

N79-14028* Air Force Inst of Tech, Wright-Patterson AFB, Ohio. School of Engineering

CALCULATION OF AERODYNAMIC PRESSURE DISTRIBUTIONS ON ARBITRARY AIRCRAFT GEOMETRIES USING THE WOODWARD AERODYNAMIC ANALYSIS PROGRAM M & Thesis

Glynn E Sisson Sep 1977 99 p refs (AD-A059709, AFIT/GAE/AE/77S-2) Avail NTIS HC A05/MF A01 CSCL 20/4

There is a frequent need for accurate aerodynamic force data in preliminary design. Data must be available on many configurations some of which deviate significantly from existing aircraft. A method which fills the gap between statistically based predictions and wind tunnel testing is a computer solution to the linearized potential flow equations of motion. The Woodward USSAERO program was selected to calculate potential flow force distributions on arbitrary aircraft geometry. Five major aspects of the program insure that the program is capable of supplying the required data. They are the differential equation boundary conditions, singularity types, matrix operations, and force and moment calculations. In order to operate this program in the preliminary design environment, it was interfaced with existing geometry data bases with a separate Interface program. A third program, the Geometry program, was written to speed the definition of a complete aircraft configuration in a format compatible with several existing analysis programs. It defines arbitrary fuselage geometry as a series of cross-sections using an interactive terminal and digitizer. It defines lifting surface geometry as a series of streamwise airfoil sections with several different airfoil shapes being available. The system of programs were applied to the F-111A aircraft as an example case. The results of that analysis show excellent agreement with wind tunnel data for pressure distributions on the wing at moderately high subsonic Mach numbers. GRA

N79-14029* Detroit Diesel Allison, Indianapolis, Ind. Research on Aeroelastic Phenomena in Thin Airfoil Cascades. Final Summary Report

Sanford Fleeter Aug 1978 56 p refs (Contract N00014-72-C-0351) (AD-A059718, DDA-EDR-9575) Avail NTIS HC A04/MF A01 CSCL 21/5

The advent of high tip high work, blading in the fan stages of advanced gas turbine engines has led to the recognition of a new type of blading instability - unstalled supersonic flutter. As a result, a concerted effort to develop an appropriate predictive mathematical model has taken place. To determine the range of validity and to direct refinements to the basic flow model

fundamental supersonic oscillating cascade data are required. This is the report for an experimental research program directed at obtaining these unique time-variant aerodynamic data. The approach involved harmonically oscillating dynamically instrumented 2-D rectilinear cascades of airfoils in a supersonic inlet flow field with the unsteady operation of the cascade computer controlled. Data were obtained in both torsion and translation over a range of steady and time-variant aerodynamic conditions. All of these data were then correlated with predictions obtained from a current state-of-the-art model. GRA

N79-14030# ARO, Inc. Arnold Air Force Station Tenn
A SUMMARY REPORT ON STORE HEATING TECHNOLOGY
Final Report, Mar 1977 - Apr 1978
 R K Matthews AEDC Sep 1978 56 p refs
 (AF Proj 2567)
 (AD-A059415 AEDC-TR-78-46) Avail NTIS
 HC A04/MF A01 CSCL 01/3

One of the problem areas associated with the supersonic carriage of external stores is concerned with temperature restrictions on critical components. Theoretical calculations were used to guide a two-phase experimental program which included both flight and wind tunnel testing. Flight heat-transfer measurements were obtained on a pylon-mounted BDU-12 at flight conditions of 40 000 ft and Mach numbers up to 2.5. The wind tunnel tests of a 1/15 scale model included both pressure and heat transfer measurements on the flight test configuration plus several others. The results are discussed in three categories, wind tunnel flight test and correlation of wind tunnel and flight data. This work has clearly shown the flight capability for supersonic carriage of large stores and has demonstrated some of the available technology for defining thermal environments. Author (GRA)

N79-14031# Transportation Systems Center Cambridge Mass
PROCEEDINGS OF THE AIRCRAFT WAKE VORTICES
CONFERENCE
 J N Hallock ed Jun 1977 354 p Conf held at the Transportation Systems Center Kendall Square Cambridge Mass 15-17 Mar 1977 Sponsored by FAA
 (AD-A055510 DOT-TSC-FAA-77-12) Avail NTIS
 HC A16/MF A01 CSCL 01/2

This volume contains the proceedings of a conference on aircraft wake vortices. The contributed papers discuss technological advances in the knowledge of the phenomenon its effects on aircraft, alleviation techniques and vortex avoidance systems designed to permit decreases in delays at major airports. GRA

N79-14034# Lockheed Missiles and Space Co Huntsville Ala
 Research and Engineering Center
LASER DOPPLER VELOCIMETER MEASUREMENTS OF
B-747 WAKE VORTEX CHARACTERISTICS Final Report,
Nov 1975 - Jan 1977
 M R Brashears and A D Zalay Sep 1977 220 p refs
 (Contract DOT-TSC-1145)
 (AD-A048275, LMSC-HREC-TR-D496975 FAA-RD-77-85,
 FAA-77-13) Avail NTIS HC A10/MF A01 CSCL 01/1

To determine the behavior of the wake vortices of a B-747 at low altitudes and to measure the vortex-decay process behind the B-747 as a function of altitude above ground flap and spoiler settings and different flight configurations a B-747 aircraft flew 54 passes at low level over a ground-based Laser Doppler Velocimeter (LDV) system. From the LDV measurements the location and flow field of the wake vortices and the general vortex roll-up transport and decay trends were obtained. Results of the study indicated that the deployment of spoilers and flaps enhanced the decay of the vortex peak tangential velocity in the near wake while aircraft altitude glide slope, and landing gear deployment had little effect. The report discusses the LDV wake vortex measurements including the instrumentation used the experimental test sequence the results of the wake measurements in terms of the vortex roll-up transport, and decay trends and a comparison of the wake vortex characteristics for different configurations. Author (GRA)

N79-14036# Washington Univ St Louis Mo Dept of Mechanical Engineering
EFFECT OF STRUCTURAL PARAMETERS ON THE FLAP-LAG RESPONSE OF A ROTOR BLADE IN FORWARD FLIGHT
Interim Technical Report, Mar 1977 - Jun 1978
 David A Peters and Daniel P Schrage Jul 1978 107 p refs
 (Grant DAAG29-77-G-0103)
 (AD-A060331 ARO-14585 1-E ITR-1) Avail NTIS
 HC A06/MF A01 CSCL 01/3

A study is made of the effect of structural coupling on the vibrations of rigid centrally hinged rotor blades. In particular if the parameter combinations that result in desirable stability characteristics might also result in good vibrational characteristics. In order to determine the stability and vibrations simultaneously, a new analytical method, based on eigenvalue and modal decoupling, is developed to solve for the eigenvalues and forced response of systems of equations with periodic coefficients. This method is then applied to the linearized equations of motion for rotor flap-lag in forward flight. Unlike conventional linear analyses however this analysis retains the nonlinear terms as added forcing functions. GRA

N79-14038# McDonnell Aircraft Co St Louis Mo
LIFT SYSTEM INDUCED AERODYNAMICS OF V/STOL
AIRCRAFT IN A MOVING DECK ENVIRONMENT
VOLUME 1 TECHNICAL DISCUSSION Final Technical
Report, 30 Sep 1977 - 29 Sep 1978
 James H Kamman and Charles L Hall 29 Sep 1978 192 p refs
 (Contract N62269-77-C-0365)
 (AD-A060206 NADC-77107-30-Vol-1) Avail NTIS
 HC A09/MF A01 CSCL 01/2

The propulsive lift system induced aerodynamics of multi-jet V/STOL aircraft configurations were experimentally evaluated over a moving deck and at static hover conditions. Several model configurations representative of advanced subsonic and supersonic V/STOL aircraft were tested. Dynamic jet-induced force and moment data were obtained for heaving pitching, and rolling motions of a simulated seaborne landing platform over a range of heights, amplitudes, and frequencies. Configuration effects were assessed at both static hover and deck motion conditions, including the effects of wing height fuselage contouring, lift improvement devices and nozzle arrangement. In addition tests were performed to separate the effects of deck motion on the fountain impingement forces. Empirical procedures were defined to aid in predicting the dynamic jet-induced forces and moment variations with deck motion. Configuration design and model testing guidelines for V/STOL aircraft are described. Recommendations are also made for further research to provide additional information required to develop generalized prediction procedures. Author (GRA)

N79-14044# University of Southern Calif Los Angeles Dept of Aerospace Engineering
THEORY OF OBLIQUE WINGS OF HIGH ASPECT RATIO
 H K Cheng May 1978 45 p refs
 (Contract N00014-75-C-0520)
 (AD-A059798 USCAE-135) Avail NTIS HC A03/MF A01
 CSCL 20/4

The aerodynamic characteristics of oblique wings in an inviscid incompressible flow linearized for small wing camber and incidence are studied under the assumption that the wing aspect ratio is high. The present analysis differs from the classical lifting-line theory in that the flow field next to the wing section (the inner solution) is affected by a component of the wake vorticity parallel to the center line, and hence is not locally two-dimensional. A crucial aspect of the analysis involves the behavior of the three-dimensional corrections near the leading and trailing edges which require special attention lest nonuniformities arise. The results determined from matching the inner and outer solutions exhibit a strong asymmetrical spanwise influence of the wake vorticities with a lift increase on the downstream wing panel and a lift reduction on the upstream panel. Results obtained are compared with surface-lift distributions generated by an inversed method for yawed elliptic planforms and with

span loadings generated by a panel method for elliptic flat plates (wings with zero camber) as well as an ESP (extended-span planform) wing
GRA

N79-14047# Naval Ship Research and Development Center
Bethesda Md Aviation and Surface Effects Dept
DYNAMIC RESPONSE OF LIFT FANS SUBJECT TO VARIOUS BACKPRESSURE

John M Durkin and Lawrence H Luehr Jul 1978 18 p refs
Presented at the AIAA/SNAME Advanced Marine Vehicles Conf
San Diego, Calif, 17-19 Apr 1978
(AD-A057292 AERO-1253 AIAA-Paper-78-75,
DTNSRDC-78/063) Avail NTIS HC A02/MF A01 CSCL 13/7

An analytical investigation of the dynamic performance of a centrifugal lift fan was conducted to provide an explanation for the behavior which occurred when the fan was subjected to a varying backpressure. Analysis of test data shows that the fan response $\Delta Q/\Delta P$ can be represented by a first-order lag system. An in-depth analysis of the various elements of the lift fan system revealed that the inertia of the air within the fan was the primary contributor to the observed fan behavior. The analysis further showed that variations in fan speed would not produce the behavior measured in the test and that the response due to the compliant properties of air within the fan occurs at a frequency that is much higher than the frequency range of the test. A time-domain digital computer program has been developed which integrates the rate of change of fan flow with a varying backpressure. Good correlation is exhibited between test data and the computer predictions at all frequencies.
Author (GRA)

N79-14063# National Transportation Safety Board Washington
D C Bureau of Technology

ANNUAL REVIEW OF AIRCRAFT ACCIDENT DATA, U S AIR CARRIER OPERATIONS, 1977

6 Sep 1978 90 p
(PB-287423/8, NTSB-ARC-78-2) Avail NTIS
HC A05/MF A01 CSCL 01A

The record of aviation accidents in all operations of the U S air carriers for calendar year 1977 are presented. It includes an analysis by class of carrier and type of service in which the 1977 performances were compared with 5-year base-period averages. A 10-year review, 1968 through 1977, of the certificated route carriers is presented for accident rates by aircraft make and model, types of accidents, phases of operation, causes or related factors, and a comparison between scheduled and nonscheduled revenue service. Statistical tables which summarize the accidents, fatalities, and accident rates, causal tables, and briefs of accidents are presented in the appendixes.
GRA

N79-14059# National Aviation Facilities Experimental Center
Atlantic City N J

TESTING THE FEASIBILITY OF DIFFERENTIAL OMEGA FOR AIRBORNE USE Final Report, Jul 1975 - Sep 1977

Robert Erikson Aug 1978 27 p
(FAA Proj 043-304-500)
(AD-A059329, FAA-NA-78-10 FAA-RD-78-91) Avail NTIS
HC A03/MF A01 CSCL 17/7

The testing conducted at the National Aviation Facilities Experimental Center (NAFEC) in order to determine the critical characteristics of one airborne feasibility model Differential Omega System is presented. Through static testing, dynamic simulation, and actual test flights in the Atlantic City, New Jersey area, Differential Omega was compared to Skywave-corrected and uncorrected Omega. These experiments provided data to determine the operating range, accuracy, the limits of system performance, and an accuracy comparison using three different phase correction techniques. It was found that Differential Omega was the most accurate system with no noticeable decrease in accuracy up to 150 nautical miles. Improvements to the Differential Omega system which may be incorporated into later units to improve their capability were outlined.
S E S

N79-14060# SRI International Corp Menlo Park Calif
POLICY IMPACTS OF ATC AUTOMATION. HUMAN FACTORS CONSIDERATIONS Final Report

G J Couluris M G Tashker and M C Penick Jan 1978
134 p refs Prepared in cooperation with Payne-Maxie Consultants Berkeley, Calif
(Contract DOT-FA76WAI-635 SRI Proj 5719)
(AD-A051064, FAA-AVP-78-1 Payne-Maxie-Consultants-036)
Avail NTIS HC A07/MF A01 CSCL 05/8

This report examines the future policy impact implications of advanced air traffic control (ATC) systems which might be developed by the Federal Aviation Administration (FAA). It studies impacts of ATC automation on sector air traffic controllers, with emphasis placed on the identification of human factors problems that may arise in the future if higher levels of automation are implemented. Of particular concern are those human factors that may in some manner determine the direction of automation development or impede the implementation of automation. Using descriptions of technological components currently proposed by the FAA, six ATC system operations were defined. These systems represent various levels of automation development from the current system to a system in which the human controller acts as a systems data manager. The systems were evaluated in terms of 17 factors describing job satisfaction and motivation, man-machine interface, and failure mode operations in order to identify critical operational characteristics for each system.
GRA

N79-14061# Bendix Corp Baltimore, Md Communications Div

DESIGN, FABRICATION, AND TESTING OF BRASSBOARD MODEL ATCRBS BASED SURFACE TRILATERATION DATA ACQUISITION SUBSYSTEM Final Report, Jun - Dec 1975

A L Brockway J B Kuhl and P J Woodall Dec 1977
39 p refs
(Contract DOT-TSC-769)

(AD-A051148 BENDIX-489A10A FAA-RD-77-174
FAA-77-26) Avail NTIS HC A03/MF A01 CSCL 17/7

Field-test results are emphasized in this report which also contains background information on airport surface traffic control (ASTC) and the contract objectives. The field-test series proved the technical feasibility of an air traffic control radar beacon system (ATCRBS) based ASTC sensor system. Operational data acquisition subsystem (DAS) performance projections developed to date as a result of the test series are presented, and a recommendation for pursuit of further testing is substantiated.
Author (GRA)

N79-14064# Transportation Systems Center Cambridge, Mass
EXPERIMENTAL BCAS PERFORMANCE RESULTS Interim Report, Apr 1975 - May 1978

Janis Vilcans Edward Quish, Juris G Raudseps Herbert Glynn, and Benjamin S Goldstein Jun 1978 416 p refs
(AD-A058936 TSC-FAA-78-9 FAA-RD-78-53) Avail NTIS
HC A18/MF A01 CSCL 01/4

The results of the (Litchford) Beacon-based Collision Avoidance System concept feasibility evaluation are reported. Included are a description of the concept, analysis and flight test results. The system concept is based on the range and bearing measurements for detecting and resolving a threat. The experimental hardware developed under Contract No DOT-TSC-1103 Task 1-8 did not implement the automatic radar selection and lock-on mode and the capability to compute target range and bearing in real time which the concept requires. These enhancements are currently being implemented. All three generic modes of the BCAS were evaluated. These are the passive (listen-in), the active (interrogate by on-board transmitter), and the combined (active-passive). Also, reported are results of the comprehensive in-house study effort conducted on the azimuth signal requirements and on single-site feasibility. It is concluded that the BCAS is a technically feasible concept and that the passive mode with an azimuth reference signal would be more

accurate and less troublesome than other BCAS alternatives. For each operating mode there are geometries in which system performance fails or is degraded to some degree. System reliability may therefore require the implementation of various operating modes. Author (GRA)

N79-14065# Bendix Corp. Baltimore, Md. Communications Div.

DESIGN, FABRICATION, AND TESTING OF A BRASS-BOARD MODEL ATCRBS BASED SURFACE TRILATERATION DATA ACQUISITION SUBSYSTEM. Final Report. Jun - Dec 1977

A. L. Brockway, J. B. Kuhl, and P. J. Woodall. Jun 1978. 180 p. refs.

(Contract DOT-TSC-769)

(AD-A057933 BENDIX-489A09A DOT-TSC-FAA-78-7

FAA-RD-78-63) Avail NTIS HC A09/MF A01 CSCL 17/7

Field test results are emphasized in this report which also contains background information on Airport Surface Traffic Control (ASTC) and the contract objectives. The National Aviation Facilities Experimental Center (NAFEC) field test series conclusively proved the technical feasibility of an Air Traffic Control Radar Beacon System (ATCRBS) based Airport Surface Traffic Control sensor system. Operational Data Acquisition Subsystem (DAS) performance projections developed to date as a result of the National Aviation Facilities Experimental Center test series are presented and a recommendation for pursuit of Contract Option 2 is substantiated. Author (GRA)

N79-14066# Transportation Systems Center, Cambridge, Mass. **SYSTEMS INTEGRATION ANALYSIS FOR FUTURE TOWER CAB CONFIGURATIONS/SYSTEMS. Interim Report, Jul - Oct 1977**

V. J. Hobbs, D. F. Clapp, P. Rempfer, L. E. Stevenson, and D. Devoe. Jun 1978. 310 p. Continuation of Rept FAA-EM-77-10 DOT-TSC-FAA-77-19. FAA-EM-77-16 DOT-TSC-FAA-78-2

(AD-A059006, TSC-FAA-78-6, FAA-EM-77-10,

DOT-TSC-FAA-77-19, FAA-EM-77-16 DOT-TSC-FAA-78-2) Avail NTIS HC A14/MF A01 CSCL 17/7

This report presents the results of the analysis of various aspects of the integration of future ATC systems into the tower cab. The impact on the tower cab environment is analyzed from several points of view: how the systems information and displays might be used to approach idealized controller station configurations; how the cab equipment and displays resulting from these systems might be fitted into existing controller station configurations; how those systems--some not yet fully defined--might evolve and interact with the present and future systems; how the data-processing functions and equipment might be integrated; and how or if economies might be achieved through common siting of certain system sensors. GRA

N79-14071# Stanford Research Inst. Menlo Park, Calif. **ATLANTA CENTER UPGRADED THIRD GENERATION ENROUTE ATC SYSTEM OPERATIONS. A CASE STUDY. Final Report**

George J. Couluris, Jerome M. Johnson, and H. Steven Procter. Mar 1977. 156 p. refs.

(Contract DOT-FA75WA-3714)

(AD-A056180 FAA-AVP-77-22)

Avail NTIS

HC A08/MF A01 CSCL 17/7

This report documents the work performed to assess the impact of Upgraded Third Generation Enroute Air Traffic Control (ATC) System alternatives on control facility operations. The various enhancement features are considered to be added incrementally to the current National Airspace System (NAS) Stage A enroute ATC operation and include automatic data handling enroute metering automated local flow control conflict probe area navigation Discrete Address Beacon System (DABS) data link and DABS-based intermittent positive control. Staffing estimates for each enhancement system are made for the Atlantic Air Route Traffic Control Center for the years 1980 through 2000, and include Air Traffic Service and Airway Facilities Service personnel. The estimation procedure uses models previously developed by SRI based on extensive observations of ATC

operations. These models include the Relative Capacity Estimating Process (RECEP) which relates ATC sector controller workload requirements to traffic capacities and the Air Traffic Flow (ATF) network simulation model, which assesses traffic capacity and delay in a multisector environment. GRA

N79-14075# Naval Air Engineering Center, Lakehurst, N.J. Engineering Dept.

FRESNEL LENS OPTICAL LANDING SYSTEM MK6 MOD 3 STABILIZATION CIRCUIT BOARD TEST SPECIFICATIONS. Final Technical Report

W. F. Davis. 19 Sep 1978. 125 p.

(AD-A059786 NAEC-9-7917) Avail NTIS HC A06/MF A01 CSCL 09/1

This is a test procedure for the printed circuit boards in the stabilization section of the Fresnel Lens Optical Landing System MK 6 Mod 3. The tests are intended to be only functional screening tests for the assembled boards. The tests do not provide burn-in nor accelerated life tests for individual components. Author (GRA)

N79-14077# Naval Air Rework Facility, Norfolk, Va. **EVALUATION OF A COMMERCIAL OMEGA NAVIGATION SYSTEM INSTALLED IN THE C-118 AIRCRAFT**

Clifton G. Wrestler, Jr. 26 Sep 1978. 23 p. refs.

(AD-A060154, NARF-C-118-WSM-1-78) Avail NTIS HC A02/MF A01 CSCL 17/7

A Commercial OMEGA Navigation System (ONS) Litton LTN 201, was flight tested to determine the suitability of the system to meet the commercial specifications and the Navy's long-range overwater navigation requirements for the C-118 aircraft. The ONS on the C-118 aircraft had a position error of less than 1 nautical mile (commercial spec error no greater than 7 nautical miles) for the three areas of operation, CONUS, Caribbean and Mediterranean. Signal to noise ratio readings indicate six stations were available for navigation at all times. Seven stations are the maximum number of stations which can be used for navigation due to algorithms in the LTN 201. In the Mediterranean area, seven stations were available for navigation in 85% of the samples taken. No point estimates can be made on the reliability of the ONS. With approximately 150 flight hours there were no failures. A Commercial OMEGA Navigation System will satisfy the long-range overwater navigation requirement in the Atlantic, Caribbean, and Mediterranean for the C-118 aircraft. Author (GRA)

N79-14078# Royal Aircraft Establishment, Farnborough (England)

ON THE LIMITS OF STEEP HELICOPTER APPROACHES

M. Rade. Apr 1978. 19 p. refs. Transl. into ENGLISH of: Ueber die Grenzen von steilen Fluegen mit Drehflueglern, Rept MBB-UD-101-73, May 1973.

(RAE-Lib-Trans-1960 BR65223)

Avail NTIS

HC A02/MF A01

The flight conditions and limitations influencing steep helicopter approaches are described. The limits for steep instrument approaches stated and actual flight results are indicated. An approach angle of 15 degrees shows considerable advantages over a normal ILS approach. A few essential conditions for steep instrument approaches are briefly introduced. Author

N79-14079# Hughes Helicopters, Culver City, Calif. **APPLICATION OF HIGHER HARMONIC BLADE FEATHERING FOR HELICOPTER VIBRATION REDUCTION**

Richard W. Powers. Apr 1978. 39 p. refs.

(Contract NAS1-14552)

(NASA-CR-158985) Avail NTIS HC A03/MF A01 CSCL 01C

Higher harmonic blade feathering for helicopter vibration reduction is considered. Recent wind tunnel tests confirmed the effectiveness of higher harmonic control in reducing articulated rotor vibratory hub loads. Several predictive analyses developed in support of the NASA program were shown to be capable of calculating single harmonic control inputs required to minimize

a single 4P hub response. In addition, a multiple-input, multiple-output harmonic control predictive analysis was developed. All techniques developed thus far obtain a solution by extracting empirical transfer functions from sampled data. Algorithm data sampling and processing requirements are minimal to encourage adaptive control system application of such techniques in a flight environment. G G

N79-14080* National Aeronautics and Space Administration Langley Research Center Hampton, Va

STRUCTURAL CONCEPTS AND EXPERIMENTAL CONSIDERATIONS FOR A VERSATILE HIGH-SPEED RESEARCH AIRPLANE

L Robert Jackson F S Kirkham and J P Weidner Nov 1978 90 p refs

(NASA-TM-78743) Avail NTIS HC A05/MF A01 CSCL 01C

Future aircraft may be hydrogen fueled and fly at hypersonic speeds. The resulting environments will require new structural concepts to satisfy performance goals. Large representative structures will have to be flight tested prior to commitment to a costly vehicle fleet. To perform flight tests a versatile economical high-speed research airplane is defined. Results of this study including experimental considerations for a hypersonic research airplane are reported. Author

N79-14081* National Aeronautics and Space Administration Langley Research Center Hampton, Va

IMPROVEMENTS TO THE FATOLA COMPUTER PROGRAM INCLUDING NOSEWHEEL STEERING SUPPLEMENTAL INSTRUCTION MANUAL

Huey D Carden and John R McGehee Dec 1978 64 p refs (NASA-TM-78768 L-12295) Avail NTIS HC A04/MF A01 CSCL 01C

Modifications to a multidegree of freedom flexible aircraft take-off and landing analysis (FATOLA) computer program, which improved its simulation capabilities, are discussed, and supplemental instructions for use of the program are included. Sample analytical results which illustrate the capabilities of an added nosewheel steering option indicate consistent behavior of the airplane tracking attitude motions, and loads for the landing cases and steering situations which were investigated. Author

N79-14082* National Aeronautics and Space Administration Ames Research Center Moffett Field Calif

EFFECTS OF VISUAL AND MOTION SIMULATION CUEING SYSTEMS ON PILOT PERFORMANCE DURING TAKEOFFS WITH ENGINE FAILURES

Benton L Parris and Anthony M Cook Dec 1978 85 p (NASA-TP-1365 A-7352) Avail NTIS HC A05/MF A01 CSCL 05H

Data are presented that show the effects of visual and motion during cueing on pilot performance during takeoffs with engine failures. Four groups of USAF pilots flew a simulated KC-135 using four different cueing systems. The most basic of these systems was of the instrument-only type. Visual scene simulation and/or motion simulation was added to produce the other systems. Learning curves, mean performance, and subjective data are examined. The results show that the addition of visual cueing results in significant improvement in pilot performance, but the combined use of visual and motion cueing results in far better performance. Author

N79-14083* National Aeronautics and Space Administration Langley Research Center Hampton, Va

DEVELOPMENT AND VALIDATION OF A PILOTED SIMULATION OF A HELICOPTER AND EXTERNAL SLING LOAD

J D Shaughnessy Thomas N Deaux (Sperry Support Services Hampton, Va) and Kenneth R Yenni Jan 1979 113 p refs (NASA-TP-1285 L-11925) Avail NTIS HC A06/MF A01 CSCL 01C

A generalized real time piloted, visual simulation of a single rotor helicopter suspension system and external load is described and validated for the full flight envelope of the U.S. Army CH-54 helicopter and cargo container as an example. The mathematical model described uses modified nonlinear classical

rotor theory for both the main rotor and tail rotor nonlinear fuselage aerodynamics, an elastic suspension system, nonlinear load aerodynamics, and a loadground contact model. The implementation of the mathematical model on a large digital computing system is described, and validation of the simulation is discussed. The mathematical model is validated by comparing measured flight data with simulated data, by comparing linearized system matrices, eigenvalues, and eigenvectors with manufacturers data and by the subjective comparison of handling characteristics by experienced pilots. A visual landing display system for use in simulation which generates the pilot's forward looking real world display was examined, and a special head up, down looking load/landing zone display is described. Author

N79-14084* Lockheed-California Co Burbank

NATURAL ICING FLIGHT TESTS AND ADDITIONAL SIMULATED ICING TESTS OF A UH-1H HELICOPTER INCORPORATING AN ELECTROTHERMAL ICE PROTECTION SYSTEM Final Report, 17 Feb - 15 Apr 1977

Richard H Cotton Jul 1978 205 p refs (Contract DAAJ02-77-C-0002 DA Proj 1H2-63209-D-103) (AD-A059704 LR-28240 USAAMRDL-TR-77-36) Avail NTIS HC A10/MF A01 CSCL 01/3

Natural icing flights and additional simulated icing tests were accomplished with a UH-1H helicopter equipped with an advanced ice protection system. This testing was the third icing test program accomplished with the test aircraft, but the first to include natural icing conditions. The simulated icing tests were conducted in the National Research Council (NRC) spray rig at Ottawa, Canada. The natural icing flights were made from the Ottawa International Airport. Seven tests in the spray rig and ten natural icing flights were made totaling 30.4 flight hours of icing testing. Icing was encountered on five of the natural icing flights. The icing conditions ranged from 9.15 gram per cubic meter liquid water content at -18 C to 0.30 grams per cubic meter at -2 C. The aircraft operated in icing conditions on each of the flights from 40 minutes to a little over one hour. The number of main blade de-icing cycles required under the conditions experienced varied from three to five. GRA

N79-14085* Kaman Aerospace Corp Bloomfield Conn

DESIGN, FABRICATION AND LABORATORY TESTING OF A HELICOPTER COMPOSITE MAIN ROTOR HUB Final Report

Robert J Mayerjak Aug 1978 214 p refs (Contract DAAJ02-75-C-0013 DA Proj 1F2-62209-AH-76) (AD-A060313 USARTL-TR-78-16) Avail NTIS HC A10/MF A01 CSCL 01/3

A new graphite-epoxy rotor hub was designed for the CH-54B helicopter, and a 1/2 scale structural model was fabricated. The hub consisted of three composite plates which cooperated well to provide efficient load paths. The composite plates were simple and readily fabricated. As a result, the new hub promises improvements in cost, weight, damage tolerance, radar detectability, and maintainability when compared to conventional metal hubs. GRA

N79-14086* Boeing Commercial Airplane Co, Seattle Wash

REPAIR OF BONDED PRIMARY STRUCTURE Final Report, Sep. 1976 - May 1978

J E McCarty, R E Horton, M C Locke, R Z Mayberry and M L Satterthwait Jun 1978 119 p (Contract F33615-76-C-3137) (AD-A059945 AFFDL-TR-78-79) Avail NTIS HC A06/MF A01 CSCL 11/1

This report describes a program to develop durable cost-effective repair methods for adhesive bonded primary structure. Tasks included the evaluation and selection of adhesive systems, the design analysis and demonstration of repair methods, and the performance of cost and flow time studies. Facilities and equipment required at the repair depots to accomplish these repairs were identified. Author (GRA)

N79-14087* Naval Postgraduate School Monterey Calif

COMPUTERIZATION OF TACTICAL AIRCRAFT PERFORM-

ANCE DATA FOR FLEET APPLICATION M S Thesis

William Morris Siegel Jun 1978 53 p refs
(AD-A059912) Avail NTIS HC A04/MF A01 CSCL 15/7

The nature of operations, variety of missions and configurations and requirement for rapid response of fleet tactical aircraft has given rise to a unique problem within the Naval Aviation community, this being the interface between the aircrews and the aircraft performance prediction information supplied via charts and data in the Naval Air Training and Operating Procedures Standardization (NATOPS) Manuals. The data presented are not optimally used due to the method of presentation and the time and effort required to extract useful predictions. This investigation addressed the problem by developing a suitable method of NATOPS curve presentation that has sufficient simplicity and accuracy for application to current compact computers. The procedure is defined and numerical algorithms produced which demonstrate the feasibility and desirability of this type of implementation. Author (GRA)

**N79-14088# Civil Aviation Administration London (England)
DYNAMIC RESPONSE OF AIRCRAFT TO UNLOADED AND
LOADED PAVEMENT PROFILES Final Report**

William H Highter and Mark R Snyder Aug 1978 63 p
refs Revised
(Contract DOT-FA73WAI-361)
(AD-A059787 CEEDO-TR-77-42, FAA-RD-77-160) Avail
NTIS HC A04/MF A01 CSCL 01/3

The objective of this study was to determine whether or not there exists a significant difference in the simulated dynamic response of an F-4C aircraft traversing either an unloaded (undeflected) or loaded (deflected) pavement profile. The Air Force computer code TAXI, was adapted for use on the Clarkson College IBM 360 Model 65 computer from the CDC 6600 computer used by the Air Force Civil Engineering Center. The TAXI code calculates the vertical accelerations at three points on an aircraft traversing a pavement profile. It appears that there is no significant difference in the response of TAXI to unloaded and loaded pavement profiles at speeds up to 133.3 feet per second. At higher speeds some rejections of the mean do occur, but in light of the continuous acceptance of the test of the distribution and the predominant acceptance of the test of the mean these are felt to be insignificant. It appears that the present practice of using unloaded pavement profiles for aircraft dynamic response simulation is acceptable and loaded pavement profiles need not be obtained for this purpose.

Author (GRA)

**N79-14089# Naval Postgraduate School, Monterey Calif
ACQUISITION PLANNING FOR TACTICAL AVIONICS
SYSTEMS M S Thesis**

Cleveland Duane Englehardt Jun 1978 63 p refs
(AD-A059600) Avail NTIS HC A04/MF A01 CSCL 09/2

This thesis examines the use of microcomputer technology in tactical avionics systems and its impact on the procurement process of associated hardware and software. The rapid expansion of implementation of large scale integrated circuits in avionics systems aboard tactical military aircraft and missile systems has resulted in some serious potential problems in the areas of development, maintenance and acquisition of microprocessor-based systems and software. These problems are identified and discussed and proposed recommendations are made to lessen their undesirable long-range effects. Author (GRA)

**N79-14090# Illinois Univ at Urbana-Champaign Urbana
Decision and Control Lab
CONTROL STRATEGIES FOR COMPLEX SYSTEMS FOR USE
IN AEROSPACE AVIONICS Final Report, 30 Jun 1973 -
29 Jun 1978**

Jose B Cruz Jr 4 Aug 1978 22 p refs
(Grant AF-AFOSR-2570-73)
(AD-A059492 DC-17, T-63 AFOSR-78-1258TR) Avail NTIS
HC A02/MF A01 CSCL 14/2

The research program was focused on investigating new methods of analysis synthesis, and optimization of control systems particularly those which contain uncertain parameters and disturbance inputs. The objective was to develop methods to improve the performance of control systems by counteracting the effects of these random parameters and disturbance inputs. Several new methods which contribute to this objective were proposed and developed under this program. Among these new approaches are strategies for sensitivity adaptive feedback with estimation redistribution sensitivity reducing compensators using observers, stochastic adaptive control of systems containing random parameters, control of singularly perturbed stochastic systems, trajectory optimization of singularly perturbed systems, time scale decomposition in regulator design and high gain feedback systems and variable structure systems. The results obtained during the five year period are fully documented in 38 journal articles, 30 conference papers presented at various international congresses and national meetings and 18 technical reports of the Laboratory. Some of these results were briefly summarized in four Interim Scientific Reports submitted annually during the grant period. Author (GRA)

**N79-14091# Westinghouse Electric Corp Hunt Valley Md
THE AVIONICS LABORATORY PREDICTIVE OPERATIONS
AND SUPPORT (ALPOS) COST MODEL, VOLUME 3
Final Report, Jun 1977 - Mar 1978**

John P Turek E Louis Wienecke III and Erasmus E Feltus
Apr 1978 39 p
(Contract F33615-77-C-1105)
(AD-A059354 AFAL-TR-78-49-Vol-3) Avail NTIS
HC A03/MF A01 CSCL 15/5

Recent DOD experience shows that a prime factor in the evaluation of alternative weapon systems for performing a particular mission is Life Cycle Cost (LCC). Since 70% of the system LCC is determined by the end of the conceptual phase it is important that techniques to predict LCC be available during that phase. Since system definition is not complete enough in this phase to perform detailed analysis using accounting models, the major tool which can be used is parametric estimating models. This report describes a model which relates the available design parameters to LCC via various cost estimating relationships (CERs). This document is Volume 3 of the Final Report which describes the consolidated data base utilized to develop the Avionics Laboratory Predictive Operations and Support (ALPOS) cost model. The Air Force Program Monitor was Lt Thomas T James Jr (AFAL/AAA-3), System Evaluation Group Avionic Systems Engineering Branch. Author (GRA)

**N79-14092# Cobro Corp Silver Spring Md
EVALUATION OF AIRCRAFT EQUIPMENT MONITORING
DEVICES, PROCEDURES, AND TECHNIQUES
Final Report**

James E Marsh Jul 1978 109 p refs
(Contract DAAJ02-77-C-0052, DA Proj 1L2-62209-AH-76)
(AD-A059846 USARTL-TR-78-31 TR-11-3) Avail NTIS
HC A06/MF A01 CSCL 01/3

This report presents the results of a study of current diagnostic techniques and procedures used at the aviation unit maintenance level for Army helicopters. A projection is provided to show the potential improvement which could be attained in reliability (R), availability (A), and direct support costs (C) for selected helicopter components through improved diagnostic methods. This potential would be realized if the current field diagnostic capability were improved to the effectiveness represented by the engineering teardown underlying the Disassembly and Inspection Reports (DIRs). The validity of current diagnostic monitoring devices, techniques and procedures is presented in terms of comparison of the unit removal reason to the actual DIR finding upon teardown. A relationship of primary fault indicators to the degree of aircraft damage or loss of mission effectiveness is also presented.

Author (GRA)

**N79-14093# General Electric Co Utica N Y Aircraft
Equipment Div
MODULAR AVIONICS PACKAGING (MAP) Final Report**

30 Nov 1977 243 p refs
(Contract N00163-77-C-0295)

(AD-A059637) Avail NTIS HC A11/MF A01 CSCL 09/5
In considering Modular Avionics Packaging, the objective of the General Electric study program was to develop an avionics equipment packaging concept, compatible with MIL-E-5400 and applicable to multiplatform avionics requirements stretching into the 1990s. Specific elements evaluated were Standard Avionics Module (SAM) requirements and concepts, integrated racks and WRA requirements and concepts, and airframe interface considerations. The V/STOL Type A platform was used as the driving requirement in performing trade-off studies. Key design objectives and constraints included the following: Minimizing installed avionics weight and volume; Mechanical simplicity; Significant improvement in Reliability and Maintainability; Eliminating single-point failure modes; Direct access to Weapons Replaceable Modules (WRM); Modules capable of being conduction-cooled; Significant improvement in thermal performance; and Improved testability at all hardware levels. GRA

N79-14034# Westinghouse Electric Corp. Hunt Valley Md
THE AVIONICS LABORATORY PREDICTIVE OPERATIONS AND SUPPORT (ALPOS) COST MODEL, VOLUME 2 Final Report, Jun. 1977 - Mar. 1978

Erasmus E Feltus Wright-Patterson AFB Ohio AFAL Apr 1978 159 p refs
(Contract F33615-77-C-1105 AF Proj 2003)
(AD-A059516, AFAL-TR-78-49-Vol-2) Avail NTIS HC A08/MF A01 CSCL 15/5

Recent DOD experience shows that a prime factor in the evaluation of alternative weapon systems for performing a particular mission is Life Cycle Cost (LCC). Since 70% of the system LCC is determined by the end of the conceptual phase, it is important that techniques to predict LCC be available during the phase. Since system definition is not complete enough in this phase to perform detailed analysis using accounting models, the major tool which can be used is parametric estimating models. This report describes a model which relates the available design parameters to LCC via various cost estimating relationships (CERs). This document is Volume II of the Final Report which describes the mathematical and statistical techniques used to obtain the cost estimating relationships and parametric estimating relationships needed to develop the Avionics Laboratory Predictive Operations and Support (ALPOS) Cost Model. Author (GRA)

N79-14035* National Aeronautics and Space Administration
Lewis Research Center, Cleveland Ohio
CAM-OPERATED PITCH-CHANGE APPARATUS Patent
Philip E Barnes, inventor (to NASA) (United Technologies Corp. Windsor Locks Conn.) Issued 7 Nov 1978 8 p Filed 9 Oct 1974. Published under the second Trial Voluntary Patent Program as B 513 346 9 Mar 1976. Sponsored by NASA (NASA-Case-LEW-13050-1 US-Patent-4 124,330 US-Patent-Appl-SN-513346 US-Patent-Class-416-157B US-Patent-Class-416-162, US-Patent-Class-416-160, US-Patent-Class-416-167) Avail US Patent and Trademark Office CSCL 01C

A pitch-change apparatus for a ducted thrust fan having a plurality of variable pitch blades employs a camming ring mounted coaxially at the hub at an axially fixed station along the hub axis for rotation about the hub axis both with the blades and relative to the blades. The ring has a generally spherical outer periphery and a plurality of helical camming grooves extending in a generally spherical plane on the periphery. Each of the variable pitch blades is connected to a pitch-change horn having a cam follower mounted on its outer end and the camming ring and the horns are so arranged about the hub axis that the plurality of followers on the horns engage respectively the plurality of helical camming grooves. Rotary drive means rotates the camming ring relative to the blades to cause blade pitch to be changed through the cooperative operation of the camming grooves on the ring and the cam followers on the pitch-change horns. Official Gazette of the U S Patent and Trademark Office

N79-14036* National Aeronautics and Space Administration
Lewis Research Center, Cleveland Ohio
INTEGRATED GAS TURBINE ENGINE-NACELLE Patent
Arthur P Adamson (GE Cincinnati) Donald F Sargisson (GE, Cincinnati) and Charles L Stotler, Jr. inventors (to NASA) (GE, Cincinnati) Issued 2 Jan 1979 9 p Filed 22 Dec 1976. Continuation of abandoned US Patent Appl SN-522108 filed 8 Nov 1974. Sponsored by NASA (NASA-Case-LEW-12389-3 US-Patent-4 132,069 US-Patent-Appl-SN-753452 US-Patent-Class-60-226R US-Patent-Class-60-226A US-Patent-Class-60-39 31, US-Patent-Class-244-54 US-Patent-Class-137-15 1, US-Patent-Class-415-201 US-Patent-Class-415-200, US-Patent-Appl-SN-552108) Avail US Patent and Trademark Office CSCL 21E

A nacelle for use with a gas turbine engine is provided with an integral webbed structure resembling a spoked wheel for rigidly interconnecting the nacelle and engine. The nacelle is entirely supported in its spacial relationship with the engine by means of the webbed structure. The inner surface of the nacelle defines the outer limits of the engine motive fluid flow annulus while the outer surface of the nacelle defines a streamlined envelope for the engine.

Official Gazette of the U S Patent and Trademark Office

N79-14037* National Aeronautics and Space Administration
Lewis Research Center, Cleveland Ohio
VARIABLE AREA EXHAUST NOZZLE Patent
Everett A Johnston inventor (to NASA) (GE Cincinnati) Issued 2 Jan 1979 8 p Filed 30 Apr 1975. Sponsored by NASA (NASA-Case-LEW-12378-1 US-Patent-4 132 068 US-Patent-Appl-SN-573029 US-Patent-Class-60-226A US-Patent-Class-239-265 39) Avail US Patent and Trademark Office CSCL 21E

An exhaust nozzle for a gas turbine engine comprises a number of arcuate flaps pivotally connected to the trailing edge of a cylindrical casing which houses the engine. Seals disposed within the flaps are spring biased and extensible beyond the side edges of the flaps. The seals of adjacent flaps are maintained in sealing engagement with each other when the flaps are adjusted between positions defining minimum nozzle flow area and the cruise position. Extensible spring biased seals are also disposed within the flaps adjacent to a supporting pylon to thereby engage the pylon in a sealing arrangement. The flaps are hinged to the casing at the central portion of the flaps leading edges and are connected to actuators at opposed outer portions of the leading edges to thereby maximize the mechanical advantage in the actuation of the flaps.

Official Gazette of the U S Patent and Trademark Office

N79-14038* National Aeronautics and Space Administration
Lewis Research Center, Cleveland Ohio
EFFECT OF SWIRLER-MOUNTED MIXING VENTURI ON EMISSIONS OF FLAME-TUBE COMBUSTOR USING JET A FUEL
David B Ercegovic Jan 1979 23 p refs
(NASA-TP-1393 AVRADCOM-TR-78-41, E-9762) Avail NTIS HC A02/MF A01 CSCL 21E

Six headplate modules in a flame-tube combustor were evaluated. Unburned hydrocarbons, carbon monoxide, and oxides of nitrogen were measured for three types of fuel injectors both with and without a mixing venturi. Tests were conducted using jet A fuel at an inlet pressure of 0.69 megapascal, an inlet temperature of 478 K, and an isothermal static pressure drop of 3 percent. Oxides of nitrogen were reduced by over 50 percent with a mixing venturi with no performance penalties in either other gaseous emissions or pressure drop. G G

N79-14101# Pratt and Whitney Aircraft Group West Palm Beach Fla Government Products Div
TURBINE EXIT GUIDE VANE PROGRAM Final Report, Mar 1974 - Oct. 1977
W S Mitchell and J F Soileau Nov 1977 317 p refs
(Contract F33615-74-C-2060 AF Proj 3066)

(AD-A060343, PWA-FR-8932 AFAPL-TR-77-75) Avail NTIS
HC A14/MF A01 CSCL 21/5

This report summarizes the results of an Air Force-sponsored Turbine Exit Guide Vane (EGV) Technology Development Program. In the EGV program non-series EGV airfoils designed for spanwise maximum inlet Mach numbers of 0.75 and average gas turnings of 38.0 deg (loading levels above those typical of state-of-the-art EGVs) demonstrated high diffusion efficiencies (72.0%) and low total pressure losses (1.5%). The non-series EGV airfoils were designed (using computer graphics design techniques with predicted pressure distributions and predicted boundary layer characteristics) by tailoring the airfoil camber and thickness distributions to minimize the airfoil suction surface rate of diffusion, therefore reducing the potential for flow separation. The non-series EGV airfoils also demonstrated performance improvements relative to equivalent NASA series airfoils. GRA

N79-14102# Teledyne Ryan Aeronautical Co., San Diego, Calif
RPV ELECTRIC POWER SYSTEM STUDY PHASE 1 TECHNOLOGY ASSESSMENT Interim Technical Report, 23 Aug 1976 - 31 Mar 1978

Frederic L. Miller Jun 1978 276 p refs
(Contract F33615-76-C-2069 AF Proj 3145)
(AD-A060336, TRA-29318-06 AFAPL-TR-78-38) Avail NTIS
HC A13/MF A01 CSCL 01/3

The RPV Electric Power Study explores ways for exploiting technology and resolving critical issues affecting the electrical subsystems of remotely piloted vehicles. The objective is to define electrical components and system concepts that offer significant cost, weight and performance improvements over present day systems. Phase 1 is an assessment of technologies capable of benefitting RPV electrical systems. Phase 2 develops a plan to transfer viable technologies into RPV systems. The scope of the Phase 1 study is limited to four classes of RPV: Advanced multi-mission tactical RPV (ARPV), High-altitude, long endurance RPV (HALE), Mini-RPV and Tactical expendable decoy system (TEDS). The approach is to first survey suitable technology, estimate future requirements, determine the most critical problems in RPV electrical systems and suggest changes to military specifications and standards to make them more compatible with RPVs. For each RPV class a series of candidate electrical systems is synthesized spanning the spectrum of potentially viable systems. These are evaluated against a set of weighted evaluation criteria and the best approaches selected. GRA

N79-14103# Washington Univ., Seattle
THE AEROTHERMODYNAMICS OF AIRCRAFT GAS TURBINE ENGINES Final Report, 1975 - 1978

Gordon C. Oates, ed. Wright-Patterson AFB, Ohio AFAPL Jul 1978 782 p refs
(Grant AF-AFOSR-2783-75)
(AD-A059784 AFAPL-TR-78-52) Avail NTIS
HC A99/MF A01 CSCL 21/5

An extensive study of many aspects of the aerothermodynamics of aircraft gas turbine engines is presented. The study consists of twenty-six chapters written by a total of twenty-four authors. After an initial comprehensive introductory chapter, the report provides a review of thermodynamics and gas dynamics and of laminar and turbulent flows. The cycle analysis of ideal engines is then considered followed by the description of component losses and then the cycle analysis of non-ideal engines. Engine off-design performance is then considered followed by the description of engine/airplane matching. Succeeding chapters consider the behavior of the various components in detail. Major problem areas such as computation of turbomachinery boundary layers, aeroelasticity and unsteady aerodynamics, engine stability, engine noise, jet noise and finally the system aspects of engine installation are considered in detail. The document is intended to serve many purposes including those of text, design manual, research reference and comprehensive overview of the aerothermodynamics of aircraft gas turbine engines. Author (GRA)

N79-14104# Hamilton Standard Windsor Locks, Conn
Hamilton Standard Div
DISASSEMBLY INSPECTION AND OVERHAUL OF X-22A

GEAR REDUCTION AND PROPELLER ASSEMBLIES
Final Report, May 1977 - Jul 1978

E. H. Walz Jul 1978 105 p
(AD-A059795 NADC-76220-60) Avail NTIS
HC A06/MF A01 CSCL 01/3

This report presents the results of the disassembly inspection and overhaul of four Hamilton Standard designed and fabricated X-22A gear reduction and propeller assemblies. These units have operated intermittently since 1966 and had accumulated a total of 574 flight research hours. All functional components appeared to be in satisfactory condition and following minor corrective action, the units were returned to service. Author (GRA)

N79-14105# Pratt and Whitney Aircraft Group, West Palm Beach, Fla. Government Products Div

COMPARTMENTAL LUBRICATION SYSTEM Final Report, 6 Oct 1975 - 1 Apr 1978

E. M. Beverly Jun 1978 315 p
(Contract F33615-75-C-2075)
(AD-A060172, PWA-FR-9555, AFAPL-TR-78-32) Avail NTIS
HC A14/MF A01 CSCL 11/8

An optimum low vulnerability engine compartmental lubrication system concept was selected from quantitative analysis of five candidate schemes. The five schemes were configured based on qualitative evaluations of many lubrication system components and locations of components. Analysis showed the selected system would provide significant improvements in the areas of reduced vulnerability, maintainability, system cost, frontal area and increased reliability compared to the F100-PW-100 engine. GRA

N79-14106# United Technologies Research Center, East Hartford, Conn

RESEARCH ON CENTRIFUGAL EFFECTS ON TURBINE ROTOR BLADE FILM COOLING Final Report, May 1977 - Jul 1978

Robert P. Dring, Michael F. Blair and H. David Joslyn Aug 1978 73 p refs
(Contract F33615-77-C-2068)
(AD-A060202, UTRC/R78-912944-7 AFAPL-TR-78-63) Avail NTIS
HC A04/MF A01 CSCL 21/5

Film cooling has been studied on the rotor blade of a large scale (low speed) model of a high pressure turbine first stage. Film coolant was discharged from single holes on the pressure and suction surfaces on the airfoil. For each blowing site the coolant-to-free stream mass flux ratio and density ratio were varied from 0.5 to 1.5 and from 1.0 and 4.0 respectively. Both surface flow visualization and local film cooling effectiveness data were obtained. Film coolant effectiveness data is presented in the form of effectiveness profiles and contours downstream of each hole. The observation was made that although it can have a strong radial component, the trajectory of the film coolant was very insensitive to coolant flow conditions. The existence of the radial component of the film coolant trajectory was found to have a strong impact on the nature of the effectiveness distributions. The data have been compared with data taken by other investigators on flat surfaces and in plane cascades. Agreement between the flat plate data and the suction surface data was reasonably good. However, the pressure surface results showed a much faster decay of the effectiveness than did the flat plate data due to effects thought to be related to both curvature and radial flow. Author (GRA)

N79-14107# Civil and Environmental Engineering Development Office, Tyndall AFB, Fla. Detachment 1 ADTC

AIR QUALITY ANALYSIS OF POSSIBLE F-15 AND A-10 AIRCRAFT ENGINE MODIFICATIONS TO REDUCE POLLUTION Final Report, May 1977 - May 1978

Dennis F. Naugle, Peter S. Daley, and Harold A. Scott, Jr. Jun 1978 32 p refs
(AF Proj 2103)
(AD-A059976, CEEDO-TR-78-35) Avail NTIS
HC A03/MF A01 CSCL 21/5

The Air Force has established goals for the control of aircraft engine exhaust emissions. Neither the F-15 nor A-10 aircraft engines completely meet these goals even though they are much

less polluting than the F-4E and A-7 aircraft they often replace. This study compares air quality impacts of all four aircraft and shows the relative improvements possible with a modification/retrofit program for the F-15 and A-10 aircraft. Significant improvement is obtainable only for the A-10 hydrocarbon emissions. A five step analytical methodology is presented and can be adapted to nearly any aircraft related air quality assessment problem. Author (GRA)

N79-14108* National Aeronautics and Space Administration Langley Research Center Hampton Va

VORTEX-LIFT ROLL-CONTROL DEVICE Patent

John E Lamar inventor (to NASA) Issued 2 Jan 1979 6 p
Filed 21 Mar 1977 Supersedes N77-31176 (15 - 22 p 2900)
Continuation-in-part of abandoned US Patent Appl SN-651002
filed 21 Jan 1976

(NASA-Case-LAR-11868-2 US-Patent-4,132 375

US-Patent-Appl-SN-779429, US-Patent-Class-244-90R

US-Patent-Class-244-218 US-Patent-Class-244-46

US-Patent-Appl-SN-651002) Avail US Patent and Trademark Office CSCL 01C

A wing is described for aircraft of cropped arrow-type planform with thin leading and side edges. The wing has a pivotable tip to alter the crop angle of the wing during flight. Increasing the crop angle causes the wing side edge to become a trailing edge which reduces the strength of the side edge vortex flow. Decreasing the crop angle causes opposite results in particular the side edge is now a leading edge and can generate a leading edge vortex flow. The wing constitutes a roll control device for aircraft of the stated design particularly effective at higher angles of attack.

Official Gazette of the U S Patent and Trademark Office

N79-14109* National Aeronautics and Space Administration Hugh L Dryden Flight Research Center, Edwards Calif

DIGITAL FLY-BY-WIRE FLIGHT CONTROL VALIDATION EXPERIENCE

Kenneth J Szalai, Calvin R Jarvis, Gary E Krier Vincent A Megna (Charles Stark Draper Lab, Inc.) Larry D Brock (Charles Stark Draper Lab, Inc.), and Robert N ODonnell (Charles Stark Draper Lab, Inc.) Dec 1978 241 p refs

(NASA-TM-72860 R-1164, H-1080) Avail NTIS HC A11/MF A01 CSCL 01C

The experience gained in digital fly-by-wire technology through a flight test program being conducted by the NASA Dryden Flight Research Center in an F-8C aircraft is described. The system requirements are outlined along with the requirements for flight qualification. The system is described, including the hardware components, the aircraft installation and the system operation. The flight qualification experience is emphasized. The qualification process included the theoretical validation of the basic design, laboratory testing of the hardware and software elements, systems level testing, and flight testing. The most productive testing was performed on an iron bird aircraft which used the actual electronic and hydraulic hardware and a simulation of the F-8 characteristics to provide the flight environment. The iron bird was used for sensor and system redundancy management testing, failure modes and effects testing and stress testing in many cases with the pilot in the loop. The flight test program confirmed the quality of the validation process by achieving 50 flights without a known undetected failure and with no false alarms. SE S

N79-14110* National Aeronautics and Space Administration Langley Research Center, Hampton, Va

THEORETICAL STUDY OF THE EFFECT OF WIND VELOCITY GRADIENTS ON LONGITUDINAL STABILITY AND CONTROL IN CLIMBING AND LEVEL FLIGHT

Windsor L Sherman Dec 1978 21 p refs

(NASA-TP-1332 L-12273) Avail NTIS HC A02/MF A01 CSCL 01C

A change in the wind vector over a short distance along the flight path (wind gradient) has caused several severe airplane accidents during take-off and landing. Results of a previous study showed that in descending flight a positive wind gradient (decreasing head wind) caused severe divergent motion and a

negative wind gradient (decreasing tail wind) caused oscillatory motion which should not create a control problem. The results obtained when the same method of analysis was applied to climbing and to straight and level flight are reported. In straight and level flight a wind gradient was found to cause effects similar to those found in descending flight. In climbing flight, it was found that a negative wind gradient caused a slightly divergent oscillation that presented no control problems and a positive wind gradient caused oscillatory divergence. Results of motion studies indicated that adequate control of the airplane motions can be provided by automatic control systems. SE S

N79-14111# Army Aviation Research and Development Command St Louis, Mo

DIGITAL SYMBOLOLOGY GENERATOR PROGRAM

Tunis Robbins Sep 1978 96 p

(DA Proj 1L2-62202-AH-85)

(AD-A060216 USAAVRADCOM-TR-78-43) Avail NTIS HC A05/MF A01 CSCL 01/3

A digital symbology generator program is described. This program written for an SKC-2000 Airborne Computer is the software portion of an airborne Digital Symbology Generator (DSG) developed by the Avionics Research and Development Activity for use in simulation and flight test programs. The DSG is capable of displaying a variety of command and flight control symbols in a raster format on a standard 525 line TV monitor. The displayed output provides 256 by 256 pixels (picture elements) and can be updated at the standard TV frame rate of 30 sec.

Author (GRA)

N79-14112# Committee of the Whole House on the State of the Union (U S House)

FAA DETERMINATION OF NO HAZARD FOR STRUCTURES NEAR AIRPORTS

Washington GPO 1978 24 p Rept by Comm on Government Operations, 95th Congr 2d Sess, 12 Apr 1978

(H-Rept-95-1053 GPO-29-006 Rept-22) Avail US Capitol House Document Room

Testimony on FAA procedures and practices for determining whether buildings or other objects located near airports are obstructions in navigating airspace and air hazards to air navigation is presented. Procedures of the FCC in granting licenses and construction permits for antenna towers are also examined. SB S

N79-14113* Calspan Corp Buffalo N Y

THE TOTAL IN-FLIGHT SIMULATOR (TIFS) AERODYNAMICS AND SYSTEMS DESCRIPTION AND ANALYSIS Final Report

D Andrisani II H Daughaday J Dittenhauser and E Rynaski Nov 1978 283 p refs Sponsored in part by NASA Langley Res Center

(Contract F33615-73-C-3051)

(NASA-CR-158965 CALSPAN-AK-5280-F-10-Rev-1) Avail NTIS HC A13/MF A01 CSCL 14B

The aerodynamics, control system instrumentation complement and recording system of the USAF Total In-Flight Simulator (TIFS) airplane are described. A control system that would allow the ailerons to be operated collectively as well as, differentially to enhance the ability of the vehicle to perform the dual function of maneuver load control and gust alleviation is emphasized. Mathematical prediction of the rigid body and the flexible equations of longitudinal motion using the level 2.01 FLEXSTAB program are included along with a definition of the vehicle geometry, the mass and stiffness distribution, the calculated mode frequencies and mode shapes, and the resulting aerodynamic equations of motion of the flexible vehicle. A complete description of the control and instrumentation system of the aircraft is presented including analysis, ground test and flight data comparisons of the performance and bandwidth of the aerodynamic surface servos. Proposed modification for improved performance of the servos are also presented. JM S

N79-14114* Systems Technology Inc Mountain View, Calif
PILOTED AIRCRAFT SIMULATION CONCEPTS AND OVERVIEW

John B Sinacori Mar 1978 100 p refs

(Contract NAS2-9024)

(NASA-CR-152200 STI-TR-1074-2) Avail NTIS

HC A05/MF A01 CSCL 01C

An overview of piloted aircraft simulation is presented that reflects the viewpoint of an aeronautical technologist. The intent is to acquaint potential users with some of the basic concepts and issues that characterize piloted simulation. Application to the development of aircraft are highlighted but some aspects of training simulators are covered. A historical review is given together with a description of some current simulators. Simulator usages, advantages, and limitations are discussed and human perception qualities important to simulation are related. An assessment of current simulation is presented that addresses validity, fidelity, and deficiencies. Future prospects are discussed and technology projections are made. Author

N79-14115# H H Aerospace Design Co., Inc., Bedford, Mass THE FAA'S AIRPORT LANDSIDE MODEL ANALYTICAL APPROACH TO DELAY ANALYSIS Final Report

Daniel Gentry and Kristy M Doyle Jan 1978 106 p refs

(Contract DOT-FA76WAI-643)

(AD-A051145 FAA-AVP-78-2) Avail NTIS HC A06/MF A01 CSCL 01/5

Computer implemented analytic models have been developed which will assist in the quantitative assessment of the adequacy of the airport landside, that is the portion of the airport property not utilized by aircraft. The primary measures of adequacy are passenger delay and passenger processing time. Detailed analytic models have been derived using queuing theory for those airport landside components which are essential to passenger processing. Also, a landside analysis program has been developed to quantify airport landside delay and capacity. The major outputs of this program are the per passenger processing times and cumulative processing times at each terminal unit and groundside area in an airport for both enplaning and deplaning passengers and a summary of the delay and total processing times at an airport by terminal and for the entire airport. Processing time is separated into delay, service and travel time. This program has been applied to the existing and planned facilities at the large hub air carrier airports and a large data base has been created for these large hub airports. The data base is constructed so the data can be modified or additional data input can be made in a relatively straightforward manner. Author (GRA)

N79-14116# Federal Aviation Administration Washington, D C Office of Airports Programs

A REVIEW OF CERTIFICATED AIRPORT CRASH FIRE RESCUE SERVICE CRITERIA Final Report

Bertrand F Ruggles Dec 1977 26 p refs

(AD-A053110 FAA-AAP-78-1) Avail NTIS

HC A03/MF A01 CSCL 01/5

This study reviews the minimum level of crash fire suppression service required by Federal Aviation Regulation (FAR) Part 139 and compares the required minimum with the recommended level for Index A AA and B airports. It outlines the economic impact of the present airport index threshold criteria. It presents a discussion of the expected hazard the population base, and the operational base as factors affecting the level of crash fire and rescue (CFR) services required at airports and as factors affecting the airport's ability to support that level of CFR service. Conclusions are presented relative to the feasibility of fulfilling the following objectives: (1) Enhance the overall safety of airport operations at all Index A and AA airports without incurring increased operation and maintenance costs, (2) Minimize the increase in the operation and maintenance costs of CFR services presently being experienced by airport owners/operators when transitioning from Index AA to Index B certification and (3) Reduce the operations and maintenance costs of CFR services currently being provided at small Index B airports while maintaining or enhancing the present level of safety. Author (GRA)

N79-14117# Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio

A THERMAL INVESTIGATION OF THE AFAPL TURBINE

ENGINE HEAT TRANSFER TEST FACILITY Final Report, Mar - Dec 1974

John A Vonada Feb 1978 93 p refs

(AF Proj 3066)

(AD-A059338, AFAPL-TR-77-52) Avail NTIS

HC A05/MF A01 CSCL 14/2

An experimental investigation of the Heat Transfer Test Facility at the Air Force Aero Propulsion Laboratory was conducted to determine gas temperature distributions in the facility's combustion chamber. The combustor consists of an air-fed water-cooled duct with a hydrogen fuel injector system. Gas temperatures in the range of 1000 F to 3000 F were studied. The combustion chamber pressure was 3.4 atm and its air mass flow rate varied from 1.0-3.0 lbm/sec. Configurations of type-K and type-R thermocouples were used to measure temperature profiles parallel and perpendicular to the gas stream flow in the combustion chamber. These measurements indicated that a fairly uniform turbulent temperature profile develops at gas temperatures above 2000 F. In addition, the gas temperature was determined by (1) a thermal calculation which was based on the temperature decrease of the gas from the adiabatic flame temperature as a result of heat loss and (2) a transient type K thermocouple probe. The thermal calculation agreed with experimental data to within 6% at gas flow rates of 2.0 and 3.0 lbm/sec.

Author (GRA)

N79-14217# Dow Chemical Co Walnut Creek, Calif FABRICATION OF FIBERGLASS REINFORCED PLASTIC SURFACING UNDER WET CONDITIONS Final Report

Theo J West Sep 1978 72 p refs

(Contract N68305-77-C-0005)

(AD-A059698 CEL-CR-78 018) Avail NTIS

HC A04/MF A01 CSCL 11/2

The purpose of this investigation was to develop a system to be used in the construction of fiberglass-reinforced plastic surfacings for soil under wet conditions. The effect of water in the substrate and in the fiberglass mat on laminate properties, has been defined and solutions have been developed for some of the problems. A system of chemical components has been developed for the field placement of the reinforced plastic soil surfacings under wet conditions that is superior to that presently used and is usable with the basic spray equipment now used by the Marine Corps. GRA

N79-14230# Naval Postgraduate School Monterey, Calif APPLICATION OF LIGHT EXTINCTION MEASUREMENTS TO THE STUDY OF COMBUSTION IN SOLID FUEL RAMJETS M S Thesis

Michael Hewett Jun 1978 47 p refs

(AD-A059879) Avail NTIS HC A03/MF A01 CSCL 21/2

An experimental investigation of the combustion behavior in solid fuel ramjets was conducted. Optical light extinction measurements were employed to determine the effects of fuel composition and bypass ratio on the combustion efficiency percent and size of unburned carbon, and fuel regression rate. Utility and limitations of the optical method are presented.

Author (GRA)

N79-14231# Air Force Aero Propulsion Lab Wright-Patterson AFB Ohio

EVALUATION OF FUTURE JET FUEL COMBUSTION CHARACTERISTICS Final Report, 1 Jul 1975 - 30 Nov 1976

W S Blazowski and T A Jackson Jul 1978 74 p refs

(AF Proj 3048)

(AD-A060218, AFAPL-TR-77-93) Avail NTIS HC A04/MF A01 CSCL 21/4

Future anticipated changes in jet fuel character can be expected to have substantial combustion system effects. This report contributes technical information to assist in future definition of new jet fuel specifications formulated with the intent of minimizing total cost of system operation while maintaining performance and flight safety. The impact of lower fuel hydrogen content on combustor liner temperatures, smoke and gaseous emissions has been evaluated and improved correlations with

hydrogen content have been developed. Results obtained with the various fuel blends tested have confirmed the dominant influence of hydrogen content on combustion characteristics when compared to volatility and hydrocarbon type effects. Use of the new non-dimensional liner temperature parameter has also resulted in a good correlation of a wide variety of previous combustor data involving rich combustion systems. GRA

N79-14235# Naval Air Systems Command Washington, D C
NAVAL AIR SYSTEMS COMMAND-NAVAL RESEARCH LABORATORY WORKSHOP ON BASIC RESEARCH NEEDS FOR SYNTHETIC HYDROCARBON JET AIRCRAFT FUELS
1978 303 p refs Workshop held at Washington D C 15-16 Jun 1978

(AD-A060081) Avail NTIS HC A14/MF A01 CSCL 21/4

The Workshop emphasized the technical aspects of synthetic jet fuels. The purpose was to examine what is known about synfuels, highlight current research programs and suggest areas of basic research which are important to the future use of synthetic hydrocarbon fuels in jet aircraft. GRA

N79-14239# Systems Research Labs, Inc., Dayton Ohio
Aerosystems Research Div

HIGH ENERGY MHD FUELS DEVELOPMENT PROGRAM
Final Report, Mar 1975 - Dec 1977

Richard E Eckels Apr 1978 374 p refs

(Contract F33615-75-C-2043 AF Proj 3145)

(AD-A060156, AFAPL-TR-78-10)

Avail NTIS

HC A16/MF A01 CSCL 21/4

An analytical study compared the electrical conductivity and velocity squared product for several MHD liquid or liquified fuels. Aluminum additive to liquid hydrocarbon was found to be attractive for high power density MHD. A number of MHD power tests showed that developed emulsified slurry fuels were engineeringly feasible. Various emulsification processes are described.

Author (GRA)

N79-14247# New Mexico Univ Albuquerque Eric H Wang
Civil Engineering Research Facility

CHARACTERIZING EXPANSIVE SOILS FOR AIRPORT PAVEMENT DESIGN Interim Report, Feb 1977 - Apr 1978

Eric H McKeen and John P Nielson Aug 1978 125 p refs
(Contract DOT-FA75WAI-531)

(AD-A059785 CERF-AP-28, FAA-RD-78-89) Avail NTIS
HC A06/MF A01 CSCL 13/2

A reliable rapid method of categorizing expansive soils was developed. Three procedures are recommended: (1) measurement of bulk density change in natural soil clods, (2) determination of clay content, or (3) determination of the moisture-suction relationship with particular attention to aggregation. Each of these procedures considered correlations with soil compressibility with respect to suction changes. Actual activity depends on imposed loads, initial suction and final suction. The major obstacle to satisfactory development of this system remains the relation between differential heave and airport pavement roughness. The most acceptable criteria found were categories developed for application to residential concrete slabs on expansive soils. The limitations of this system are recognized but accepted as the best presently available. G G

N79-14294# Naval Ocean Systems Center San Diego, Calif
FIBER OPTICS USE IN THE P-3C AIRCRAFT A FIBER OPTIC INTERCONNECT SYSTEM FOR COMPUTER CONTROLLED ALPHANUMERIC DISPLAYS IN A P-3C AIRCRAFT Interim Report

A Flores 1 May 1978 15 p

(AD-A060318 NOSC/TR-272) Avail NTIS HC A02/MF A01
CSCL 17/2

A prototype fiber optic interconnect system was developed to interface the CP-901 computer data processing unit 1 with the auxiliary readout display. Installation aboard a P-3C test aircraft and a proposed long term test program are discussed.

Author (GRA)

N79-14298# Ohio State Univ Columbus Electroscience Lab

HIGH FREQUENCY SURFACE CURRENT AND CHARGE DENSITIES INDUCED ON AIRCRAFT BY A PLANE ELECTROMAGNETIC WAVE

C L Yu and W D Burnside Mar 1978 159 p refs

(Contract F29601-75-C-0086)

(AD-A059810, AD-E200173 AFWL-TR-77-155) Avail NTIS

HC A08/MF A01 CSCL 20/14

Surface current and charge densities induced on aircraft fuselage by an electromagnetic plane wave of arbitrary incidence at high frequencies is the object of this research. The primary goal of this investigation is to develop a theoretical solution for predicting the induced surface and charge densities on aircraft fuselage in an accurate and efficient manner. Since it is a study of general-type aircraft, the aircraft is modeled in its most basic form. The fuselage is assumed to be an infinitely long, perfectly conducting elliptic cylinder in its cross-section and a composite elliptic cylinder in its elevation profile. The wing, cockpit, stabilizers (horizontal and vertical) and landing gear are modeled by n sided bent or flat plates which can be arbitrarily attached to the fuselage. The solution developed in this study utilizes two elliptic cylinders, namely the roll plane and elevation plane models to approximate the principal surface profile (longitudinal and transverse) at the observation location. With the belt concept and the aid of appropriate coordinate system transformations the solution can be used to predict the surface current and charge densities induced on the fuselage in an accurate and efficient manner. The radiation patterns due to infinitesimal monopole and slot antennas on aircraft are related to the surface current and charge densities induced on the antenna location via the reciprocity theorem.

Author (GRA)

N79-14382* National Aeronautics and Space Administration
Langley Research Center, Hampton, Va

LOCKING REDUNDANT LINK Patent

Frank Henry Bonisch inventor (to NASA) (Sikorsky Aircraft, Stratford, Conn.) Issued 5 Sep 1978 6 p Filed 7 Mar 1977
Supersedes N77-18134 (15 - 09 p 1130) Sponsored by NASA

(NASA-Case-LAR-11900-1 US-Patent-4,111 068)

US-Patent-Appl-SN-775239 US-Patent-Class-74-586

US-Patent-Class-403-105, US-Patent-Class-416-61) Avail US
Patent and Trademark Office CSCL 13I

A low-friction, axially extensible strut, automatically lockable in both tension and compression for use as a secondary load path in helicopter main rotor force measurement systems is described. Official Gazette of the U S Patent and Trademark Office

N79-14397# Environmental Protection Agency, Ann Arbor, Mich
Technology Assessment and Evaluation Branch

INVESTIGATION OF TURBO-DYNE ENERGY CHAMBER (G.R. VALUE TRADEMARK) AN AIR BLEED DEVICE

F Peter Hutchins and James M Kranig Apr 1978 22 p

(PB-285381/0 Rept-78-2-FPH)

Avail NTIS

HC A02/MF A01 CSCL 13F

An air bleed device, known as G'R Valves (trademark) was tested. The test was done at the request of the Federal Trade Commission. Advertisements for the device claimed that it would lower exhaust contaminants, improve fuel economy, etc. The test was done to evaluate actual results with advertisement claims. The test results are presented in tabular form. GRA

N79-14401# Battelle Columbus Labs Ohio

FEASIBILITY EVALUATION OF ADVANCED EDDY CURRENT INSPECTION EQUIPMENT FOR USE IN NAVAL AVIATION MAINTENANCE ENVIRONMENT Final Report, 18 Jul 1977 - 16 Feb 1978

Robert P Meister and Stephen D Brown Lakehurst, N J Naval Air Eng Center 28 Sep 1978 38 p ref

(Contract N68335-77-C-1116)

(AD-A060076 NAEC-92-128) Avail NTIS HC A03/MF A01
CSCL 15/5

This report presents Phase I of a three phase program to develop a general eddy current system incorporating advanced eddy current signal processing Phase I describes feasibility and applications for general system requirements such as (1) capability to cover broad spectrum of materials and (2) incorporation of advanced eddy current concepts in a system operable by relatively unskilled operators GRA

N79-14564# Oak Ridge National Lab Tenn Div of Coal Conversion and Utilization

FLUIDIZED BED GAS TURBINE EXPERIMENTAL UNIT FOR MIUS APPLICATIONS Quarterly Progress Report, 1 Jul - 30 Sep 1975

A P Fraas Nov 1977 23 p refs

(Contracts E(49-18)-1742 HUD-H-40-72)

(ORNL/HUD/MIUS-32) Avail NTIS HC A02/MF A01

The conceptual design of an experimental coal fired closed cycle gas turbine having an electrical output of approximately 325 kW(e) is described Application to modular integrated utility systems is considered DOE

N79-14919# Air Force Inst of Tech Wright-Patterson AFB, Ohio School of Systems and Logistics

THE APPLICATION OF SYSTEM DYNAMICS TO A MANAGERIAL MODEL OF AERONAUTICAL SYSTEMS DIVISION M S. Thesis

Jerry L Elder and Michael B Nixon Jun 1978 120 p refs (AD-A059312, AFIT-LSSR-22-78A) Avail NTIS HC A06/MF A01 CSCL 05/1

Models presently available to Air Force managers are restricted in their use to particular functional areas, e.g. manpower and cost-estimating models Extensive research has indicated that useful and comprehensive managerial models of large, complex military organizations have not been developed The purpose of this research is to develop a model of the managerial decision structure and important information material and fund flows which are directly relevant to ASD's mission (planning and managing the acquisition of aeronautical systems subsystems, and associated equipment) Such a model would aid in the top level policy-making process and in understanding the system's behavior System dynamics appears to provide a most suitable methodology for this model development This initial effort is limited to the development of (1) a general conceptual model of the process by which ASD's mission is now accomplished, and (2) a detailed operating model of one segment of the general model--the process of project management--providing an example of how the general model could be further developed

Author (GRA)

N79-14996# National Aeronautics and Space Administration Lewis Research Center, Cleveland Ohio

THEORETICAL STUDY OF VTOL TILT-NACELLE AXISYMMETRIC INLET GEOMETRIES

J Dennis Hawk and Norbert O Stockman Jan 1979 29 p refs (NASA-TP-1380, E-9756) Avail NTIS HC A03/MF A01 CSCL 01A

A systematic theoretical study of VTOL tilt-nacelle inlet design parameters is reported The parameters considered are internal-lip contraction ratio, internal-lip major-to-minor axis ratio, diffuser-exit-area to throat-area ratio, maximum diffuser wall angle and shape Each of the inlets was analyzed at the same given flow condition of free-stream velocity angle between the free stream and centerline of the inlet, and diffuser-exit Mach number The effects of these geometric parameters on surface static-pressure distribution, peak surface Mach number, diffusion velocity ratio and tendency for the inlet flow to separate are presented

Author

N79-14997# Arizona Univ, Tucson Engineering Experiment Station

A NEW METHOD FOR DESIGNING SHOCK-FREE TRANSONIC CONFIGURATIONS

H Sobieczky, K-Y Fung A R Seebass, and N J Yu Jul

1978 35 p refs Presented at the AIAA 11th Fluid and Plasma Dyn Conf Seattle 10-12 Jul 1978

(Grant NSG-2112 Contract N00014-76-C-0182, Grant

AF-AFOSR-2954E-76)

(NASA-CR-158063, Paper-78-114, TED-78-04) Avail NTIS HC A03/MF A01 CSCL 01A

A method for the design of shock free supercritical airfoils, wings, and three dimensional configurations is described Results illustrating the procedure in two and three dimensions are given They include modifications to part of the upper surface of an NACA 64A410 airfoil that will maintain shock free flow over a range of Mach numbers for a fixed lift coefficient, and the modifications required on part of the upper surface of a swept wing with an NACA 64A410 root section to achieve shock free flow While the results are given for inviscid flow, the same procedures can be employed iteratively with a boundary layer calculation in order to achieve shock free viscous designs With a shock free pressure field the boundary layer calculation will be reliable and not complicated by the difficulties of shock wave boundary layer interaction Author

N79-14998# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio

AERODYNAMIC PERFORMANCE OF SCARF INLETS

John M Abbott 1979 22 p refs Presented at 17th Aerospace Sci Meeting, New Orleans, La, 15-17 Jan 1979 sponsored by AIAA

(NASA-TM-79055, E-9865) Avail NTIS HC A02/MF A01 CSCL 01A

A scarf inlet is characterized by having a longer lower lip than upper lip leading to both aerodynamic and acoustic advantages Aerodynamically, a scarf inlet has higher angle of attack capability and is less likely to ingest foreign objects while the aircraft is on the ground Acoustically a scarf inlet provides for reduced inlet radiated noise levels below the engine as a result of upward reflection and refraction of inlet radiated noise Results of a wind tunnel test program are presented which illustrate the aerodynamic performance of two different scarf inlet designs Based on these results, scarf inlet performance is summarized in a way to illustrate the advantages and limitations of a scarf inlet compared to an axisymmetric inlet Author

N79-14999# National Aeronautics and Space Administration Lewis Research Center Cleveland Ohio

EFFECT OF LIP AND CENTERBODY GEOMETRY ON AERODYNAMIC PERFORMANCE OF INLETS FOR TILTING-NACELLE VTOL AIRCRAFT

Richard R Burley 1979 27 p Presented at the 7th Aerospace Sci Meeting, New Orleans 15-17 Jan 1979 sponsored by AIAA

(NASA-TM-79056 E-9866, AIAA-Paper-79-0381) Avail NTIS HC A03/MF A01 CSCL 01A

Inlets for tilt-nacelle VTOL aircraft must operate over a wide range of incidence angles and engine weight flows without internal flow separation Wind tunnel tests of scale model inlets were conducted to evaluate the effectiveness of three geometric variables to provide this capability Increasing the lip contraction ratio increased the separation angle at all engine weight flows The optimum axial location of the centerbody occurred when its leading edge was located just downstream of the inlet lip Compared with a short centerbody, the optimum location of the centerbody resulted in an increase in separation angle at all engine weight flows Decreasing the lip major-to-minor-axis ratio increased the separation angle at the lower engine weight flows Author

N79-15004# Boeing Vertol Co, Philadelphia, Pa

INTERACTIONAL AERODYNAMICS OF THE SINGLE ROTOR HELICOPTER CONFIGURATION VOLUME 2-E HARMONIC ANALYSES OF AIRFRAME SURFACE PRESSURE DATA, RUNS 15-22, MID-SECTION Final Report, 15 Mar 1977 - 13 Feb 1978

Philip F Sheridan Sep 1978 152 p

(Contract DAAJ02-77-C-0020, DA Proj 1L2-62209-AH-76)

(AD-A060868 USARTL-TR-78-23B-Vol-2-E) Avail NTIS HC A08/MF A01 CSCL 01/3

This is the fifth of the nine-sub-volumes of Volume 2. These documents contain harmonic analyses of the waveforms generated by each of the 53 pressure transducers which covered the surface of the model fuselage and empennage. This sub-volume covers the second eight of the twenty-seven runs devoted to surface pressure testing. The analyses encompass the transducers in the middle section of the model. Test conditions and/or configurations include effects of root cut-out, vortex generators and strakes, autorotation and rotor height. Author (GRA)

N79-15005# Boeing Vertol Co. Philadelphia, Pa
INTERACTIONAL AERODYNAMICS OF THE SINGLE ROTOR HELICOPTER CONFIGURATION VOLUME 2-H HARMONIC ANALYSES OF AIRFRAME SURFACE PRESSURE DATA, RUNS 23-23, MID SECTION Final Report, 15 Mar 1977 - 13 Feb 1978

Philip F Sheridan Sep 1978 202 p
(Contract DAAJ02-77-C-0020 DA Proj 1L2-62209-AH-76)
(AD-A060869 USARTL-TR-78-23B-Vol-2-H) Avail NTIS HC A10/MF A01 CSCL 01/3

This is the eighth of the nine sub-volumes of Volume 2. These documents contain harmonic analyses of the waveforms generated by each of the 53 pressure transducers which covered the surface of the model fuselage and empennage. This sub-volume covers the final eleven of the twenty-seven runs devoted to surface pressure testing. The analyses encompass the transducers in the middle section of the model. Test conditions here involve speeds from 20 knots to 160 knots in level flight. Author (GRA)

N79-15006# Boeing Vertol Co. Philadelphia, Pa
INTERACTIONAL AERODYNAMICS OF THE SINGLE ROTOR HELICOPTER CONFIGURATION VOLUME 2-I HARMONIC ANALYSES OF AIRFRAME SURFACE PRESSURE DATA, RUNS 23-33, AFT SECTION Final Report, 15 Mar 1977 - 13 Feb 1978

Philip F Sheridan Sep 1978 201 p
(Contract DAAJ02-77-C-0020 DA Proj 1L2-62209-AH-76)
(AD-A060870 USARTL-TR-78-23B-Vol-2-I) Avail NTIS HC A10/MF A01 CSCL 01/3

This is the ninth of the nine sub-volumes of Volume 2. These documents contain harmonic analyses of the waveforms generated by each of the 53 pressure transducers which covered the surface of the model fuselage and empennage. This sub-volume covers the final eleven of the twenty-seven runs devoted to surface pressure testing. The analyses encompass the transducers in the aft section of the model. Test conditions here involve speeds from 20 knots to 160 knots in level flight. Author (GRA)

N79-15008# Boeing Vertol Co. Philadelphia, Pa
INTERACTIONAL AERODYNAMICS OF THE SINGLE-ROTOR HELICOPTER CONFIGURATION, VOLUME 1 Final Report, 15 Mar 1977 - 13 Feb 1978

Philip F Sheridan Sep 1978 304 p refs
(Contract DAAJ02-77-C-0020 DA Proj 1L2-62209-AH-76)
(AD-A060389, USARTL-TR-78-23A-Vol-1) Avail NTIS HC A14/MF A01 CSCL 01/3

A study has been conducted to understand the interactional aerodynamics problems occurring during the UTTAS development. Powered wind tunnel model data were organized and analyzed in the following categories of interactions: Rotor/ground, Rotor/fuselage, Rotor/fuselage/ground, Rotor/empennage, and Rotor/empennage/ground. The following related problem areas are considered: severe lateral trim changes during transition close to the ground, the occurrence of high vibratory aerodynamic loads on the airframe surfaces, turbulent flow on the airframe near the ground, excessive low-frequency unsteady loads on the empennage in forward flight due to the hub/rotor wake, and poor efficiency in tail rotor installations due to adverse fin loading. Author (GRA)

N79-15010# Boeing Commercial Airplane Co., Seattle, Wash
NONLINEAR INTERACTION BETWEEN MEAN AND UNSTEADY FLOWFIELDS NEAR MACH 1
Wilson C Chin 1978 29 p refs
(Contract N00014-78-C-0349)

(AD-A060789) Avail NTIS HC A03/MF A01 CSCL 20/4

The nonlinear interaction between a steady transonic mean flow and that induced by superposed small-amplitude oscillations is studied using the method of harmonic expansions. A truncated system of spectral equations is derived which accounts for both frequency and amplitude dependent changes to the mean flow as would be induced by Reynolds stress feedback, and in particular that owing to the primary harmonics. A three level mixed differencing scheme, conservative to leading order, is devised to solve for the nonlinearly coupled mean and unsteady disturbance flows. The harmonic method presented here is not as computationally efficient as existing ADI methods, for example, the recent scheme of Ballhaus and Goojian, but it does yield some insight into the governing dynamical processes, and it may be useful in nonlinear flutter analyses. Author (GRA)

N79-15011# Georgia Inst of Tech, Atlanta School of Aerospace Engineering
A STUDY OF TURBULENT FLOWS ABOUT OSCILLATING AIRFOILS Final Report, 1 Jun 1975 - 31 Aug 1978

J C Wu Sep 1978 10 p
(Grant DAAU29-75-G-0147)
(AD-A060491 ARO-13100 2-E) Avail NTIS HC A02/MF A01 CSCL 20/4

A two-equation differential model of turbulence has been studied in detail and used in conjunction with an integro-differential approach for the numerical solution of separated flow problems. A number of turbulent flow problems have been solved numerically and the results obtained have been compared with available experimental data. The most significant result of this research is that a versatile and highly efficient approach has been made available for numerically solving complex turbulent flow problems. The cornerstone of this research project is the integro-differential approach developed by the principal investigator and his co-workers. Author (GRA)

N79-15013*# National Aeronautics and Space Administration
Lewis Research Center, Cleveland, Ohio

AIRCRAFT CABIN OZONE MEASUREMENTS ON B747-100 AND B747-SP AIRCRAFT CORRELATIONS WITH ATMOSPHERIC OZONE AND OZONE ENCOUNTER STATISTICS

Porter J Perkins, J D Holdeman and Daniel J Gauntner Jan 1978 41 p refs. Presented at a Tech Briefing on Ozone, Cleveland, Ohio, 19 Jan 1978.
(NASA-TM-79060 E-9875) Avail NTIS HC A03/MF A01 CSCL 06F

Simultaneous measurements of atmospheric (outside) ozone concentration and ozone levels in the cabin of the B747-100 and B747-SP airliners were made by NASA to evaluate the aircraft cabin ozone contamination problem. Instrumentation on these aircraft measured ozone from an outside probe and at one point in the cabin. Average ozone in the cabin of the B747-100 was 39 percent of the outside. Ozone in the cabin of the B747-SP measured 82 percent of the outside, before corrective measures. Procedures to reduce the ozone in this aircraft included changes in the cabin air circulation system, use of the high-temperature 15th stage compressor bleed and charcoal filters in the inlet cabin air ducting, which as separate actions reduced the ozone to 58, 19 and 5 percent respectively. The potential for the NASA instrumented B747 aircraft to encounter high levels of cabin ozone was derived from atmospheric ozone measurements on these aircraft. Encounter frequencies for two B747-100's were comparable even though the route structures were different. The B747-SP encountered high ozone than did the B747-100's. Author

N79-15014*# National Aeronautics and Space Administration
Ames Research Center, Moffett Field, Calif
NASA AVIATION SAFETY REPORTING SYSTEM Quarterly Report, 1 Jan - 31 Mar 1978

Oct 1978 60 p refs. Prepared in cooperation with Battelle Columbus Labs., Mountain View, Calif.
(NASA-TM-78540 A-7662 QR-8) Avail NTIS HC A04/MF A01 CSCL 01C

The study deals with 165 inadvertent operations on or into inappropriate portions of the aircraft areas at controlled airports. Pilot-initiated and controller-initiated incursions are described and discussed. It was found that a majority of the pilot-initiated occurrences involved operation without a clearance, controller-initiated occurrences usually involved failure to maintain assured separation. The factors associated with these occurrences are analyzed. It appears that a major problem in these occurrences is inadequate coordination among the various system participants. Reasons for this, and some possible solutions to various aspects of the problem, are discussed. A sample of reports from pilots and controllers is presented. These relate to undesired occurrences in air transport, general aviation, and air traffic control operations, to ATC coordination problems, and to a recurrent problem in ASRS reports: parachuting operations. A sample of alert bulletins and responses to them is presented. Author

N79-15016# Boeing Aerospace Co., Seattle Wash
CREW ESCAPE CONCEPTS FOR ADVANCED HIGH PERFORMANCE AIRCRAFT Final Technical Report, 1 Sep 1977 - 1 Mar 1978

Douglas E Swanson Aug 1978 177 p refs
 (Contract F33615-77-C-2056, AF Proj 2402)
 (AD-A060519, D180-24086-1) Avail NTIS
 HC A09/MF A01 CSCL 06/7

An investigation into the critical environments associated with escape from a high performance aircraft led to the evaluation of new crew escape concepts. Five of these concepts were compared in terms of their escape capability, cost, reliability, maintainability, development risk, and impact on search and rescue operations. Following this comparison, three concepts were selected as having a potential for meeting all requirements. One concept utilizes a separable nose section for high speed or high altitude escape. Normal ejection occurs following deceleration or reduction in altitude. This concept is highly airplane configuration sensitive. The other two concepts are (1) an optional upward or downward ejection dependent upon the acceleration environment. The system is shielded by means of an extended wedge and stabilized by means of reaction jets, and (2) retained windshield/aftbody streamline. This system provides protection through attachment of the windshield to the escape seat and a streamline aftbody for stability. Author (GRA)

N79-15025*# Systems Control Inc., Palo Alto Calif
FLIGHT TEST DESIGN FOR CH-47 PARAMETER IDENTIFICATION

W E Hall Jr and J Vincent Dec 1978 203 p refs
 (Contract NAS1-14010)
 (NASA-CR-158948) Avail NTIS HC A10/MF A01 CSCL 01C

The VTOL Approach and Landing Technology (VALT) program is a significant experimental research program aimed at establishing a data base for rotorcraft operation in a terminal area environment. Work was undertaken to determine helicopter math models suitable for analyzing maneuvers along a VTOL trajectory and to apply these math models to determine the flight test procedures of greatest effectiveness in establishing helicopter dynamic characteristics in this mode of operation. As the principal result of this investigation, a flight test specification is presented for the CH-47 VALT aircraft operating along the specified VTOL trajectory of the VALT program. G Y

N79-15026# Technology Inc Dayton Ohio
STRUCTURAL AREA INSPECTION FREQUENCY EVALUATION (SAIFE) VOLUME 2 DESCRIPTION OF SIMULATION LOGIC Final Report

Carter J Dinkeloo Emerson F Horner and Martin S Moran
 Apr 1978 106 p refs
 (Contract DOT-FA74WA-3493)
 (AD-A059689, FAA-RD-78-29-Vol-2) Avail NTIS
 HC A06/MF A01 CSCL 01/3

To assist in the evaluation of proposed structural inspection programs for commercial jet transport aircraft, a logic was developed to simulate structural defects, failures, and inspections. This logic was incorporated in a computer program entitled

Structural Area Inspection Frequency Evaluation (SAIFE). SAIFE accounts for the following factors: (1) aircraft design analysis, (2) fatigue testing, (3) production service, and corrosion defects, (4) probability of crack or corrosion detection, and (5) aircraft modification economics. The initial contract effort and a subsequent parametric analysis are reported. The SAIFE simulation logic, the background data for the analytical functions, and decision making processes, and data for a typical simulation problem are presented. S E S

N79-15027# Royal Aircraft Establishment Farnborough (England)

INVESTIGATION INTO THE EFFECT OF RESIDUAL STRESSES ON FATIGUE STRENGTH AND MEASUREMENT OF RESIDUAL STRESS, WITH SPECIAL REFERENCE TO AIRCRAFT CONSTRUCTION

P Schrader and W Schuetz Aug 1978 69 p refs Transl into ENGLISH from Bundesmin fuer Verteidigung Forschungsber der Wehrtechnik (West Germany) v 77-23 1977 p 1-62
 (RAE-Lib-Trans-1977 BR66146) Avail NTIS
 HC A04/MF A01

Three promising techniques to improve fatigue life were investigated: ring and pad stress, coining, shot peening, and surface rolling. The techniques were first optimized under constant amplitude loading by systematically varying the most relevant parameter of inducing residual compressive stresses. The optimum parameter was then tested under realistic loads: a flight by flight or random sequence. Three high strength materials, Ti 6-6-2, Al-Zn MgCuAg, and a maraging steel, were tested in the form of an open hole, plane bending, and a fillet specimen. Attempts were made to measure the residual stresses induced by each method using strain gauges. It was concluded that large improvements in fatigue life are possible even under realistic stresses and sequences using shot peening, coining, and surface rolling. The improvements in life cannot be explained by residual stresses alone, at least for the aluminum alloy. Finally, it is shown that even titanium alloys can be successfully coined and even a very high strength steel can be successfully surface rolled. G G

N79-15028# Boeing Vertol Co Philadelphia Pa
CANOPY GLINT SCREENING INVESTIGATION Final Report, Aug 1976 - Jul 1977

Stephen J Blewitt and David R Gundling Sep 1978 70 p refs
 (Contract DAAJ02-76-C-0061, DA Proj 1F2-62209-AH-76)
 (AD-A060093, USARTL-TR-78-34) Avail NTIS
 HC A04/MF A01 CSCL 01/3

This report presents the results of a program which investigated alternatives to flat-plate canopy concepts to control helicopter visual detection cues and to reduce internal reflections. During the program, full-scale soft mockups were constructed, tested, and evaluated. Author (GRA)

N79-15030# TRADOC Systems Analysis Activity White Sands Missile Range, N Mex

FLIGHT PROFILE PERFORMANCE HANDBOOK VOLUME 3 AH-1G (COBRA)

Nathan H Cleek Jr and Alan J Wolfe Aug 1978 132 p
 (AD-A060056, TRASANA-TR-3-78-Vol-3) Avail NTIS
 HC A07/MF A01 CSCL 01/3

The purpose for preparing this handbook series is fourfold: (1) to validate AH-1G performance data quickly, (2) to reduce the manpower and time to prepare accurate flight profiles, (3) to standardize performance data so that the analysis community can benefit from a single reference in conducting studies, and (4) to provide a handbook that can be used for training in the mission profile planning area. GRA

N79-15031# TRADOC Systems Analysis Activity White Sands Missile Range, N Mex

FLIGHT PROFILE PERFORMANCE HANDBOOK VOLUME 4 AH-1S (COBRA)

Nathan H Cleek Jr and Alan J Wolfe Aug 1978 223 p
 (AD-A060057, TRASANA-TR-3-78-Vol-4) Avail NTIS
 HC A10/MF A01 CSCL 01/3

The purpose for preparing this handbook series is fourfold (1) to validate AH-1S performance data quickly (2) to reduce the manpower and time to prepare accurate flight profiles (3) to standardize performance data so that the analysis community can benefit from a single reference in conducting studies and (4) to provide a handbook that can be used for training in the mission profile planning area GRA

N79-15032# TRADOC Systems Analysis Activity, White Sands Missile Range, N Mex
FLIGHT PROFILE PERFORMANCE HANDBOOK VOLUME 5 YAH-64 (ADVANCED ATTACK HELICOPTER-AAH)

Nathan H Cleek Jr and Alan J Wolfe Sep 1978 130 p (AD-A060058, TRASANA-TR-3-78-Vol-5) Avail NTIS HC A07/MF A01 CSCL 01/3

The purpose for preparing this handbook series is fourfold (1) to validate YAH-64 performance data quickly (2) to reduce the manpower and time to prepare accurate flight profiles (3) to standardize performance data so that the analysis community can benefit from a single reference in conducting studies, and (4) to provide a handbook that can be used for training in the mission profile planning area GRA

N79-15033# Air Force Inst of Tech Wright-Patterson AFB Ohio School of Systems and Logistics
DEVELOPMENT OF A SYSTEMATIC TECHNIQUE FOR ANALYZING THE EFFECTIVENESS OF AIRCRAFT CLASS 4 MODIFICATIONS M S Thesis

Charlie J Coleman Jr Sep 1978 121 p refs (AD-A060551, AFIT-LSSR-10-78B) Avail NTIS HC A06/MF A01 CSCL 15/5

This study uses data from the Air Force Maintenance Requirements Data System (G098) to develop an assessment technique which uses parametric and nonparametric statistical mean difference tests to evaluate the effectiveness of Class 4 modifications. Fourteen selected modifications were evaluated to demonstrate how the G098 data were compiled and analyzed by this technique. Included in this evaluation were data on maintenance actions, manhours, NORM, NORS and failures before and after the modification. These data sets were adjusted for variations in flying hours and sorties. The data were then analyzed to determine if there were any significant improvements as a result of the Class 4 modification. A modification was determined to be effective if these improvements were part of the original stated purpose of the modification as indicated on the AFLC Form 48. The results of the study indicated that a systematic assessment technique which uses existing data could be developed. Author (GRA)

N79-15034# Army Aviation Engineering Flight Activity Edwards AFB, Calif

TS-2A AIRTANKER EVALUATION, PHASE 2 Final Report
 Joseph C Watts, Edward E Bailes, Sherwood C Spring and Jerry R Guin Mar 1978 99 p (AD-A060940, USAAEFA-77-07) Avail NTIS HC A05/MF A01 CSCL 01/3

The United States Army Aviation Engineering Flight Activity performed a limited handling qualities and performance evaluation of the TS-2A airplane modified with a retardant tank system for use in the United States Forest Service airtanker mission. The evaluation was conducted in two phases. Phase 1, prior to installation of the liquid dispensing tanks, and Phase 2 following installation of the tank modification. Phase 1 was conducted in 1972 by USAAEFA. The Phase 2 evaluation was conducted from 3 October through 6 December 1977 at Edwards Air Force Base (elevation 2302 feet) and South Lake Tahoe Airport, California (elevation 6262 feet). Thirty-three flights were accomplished for a total time of 50 hours of which 36.5 hours were productive. The tanker equipped TS-2A airplane is marginal, but satisfactory for the airtanker mission. With few exceptions, the information contained in the NATOPS flight manual as modified by the FAA supplement is correct and appropriate. Recommended changes to the NATOPS manual and FAA supplement include (1) dynamic minimum-control airspeed of 100 knots indicated

airspeed (2) rotation airspeed of 100 knots indicated airspeed for heavy gross weight operations, (3) lift-off airspeed of 105 knots indicated airspeed for heavy gross weight operations and (4) the inclusion of accelerate/stop data generated during this test plus a NOTE relative to abort takeoff emergency procedures GRA

N79-15035# National Technical Information Service Springfield Va

REMOTELY PILOTED VEHICLES, VOLUME 2 A BIBLIOGRAPHY WITH ABSTRACTS Progress Report, Nov 1975 - Nov 1978

Guy E Habercom Jr Dec 1978 234 p Supersedes NTIS/PS-77/1143 NTIS/PS-76/1034 NTIS/PS-75/876 NTIS/PS-78/1246/4 NTIS/PS-77/1143 NTIS/PS-76/1034 NTIS/PS-75/876 Avail NTIS HC \$28 00/MF \$28 00 CSCL 01C

A bibliography containing 227 abstracts concerning operation of vehicles under remote guidance and control is presented. Aircraft, drones and extraterrestrial explorers are among the areas researched. GRA

N79-15036# Advisory Group for Aerospace Research and Development Neuilly-Sur-Seine (France)

AIRCRAFT ICING

Nov 1978 136 p refs Presented at an AGARD Fluid Dyn Panel Round-Table Discussion on Aircraft Icing, Ottawa, 30 Sep 1977 (AGARD-AR-127, ISBN-92-835-1302-9) Avail NTIS HC A07/MF A01

Icing of unprotected components is one of the major problems engineers are faced with during the development phase of an aircraft. The Fluid Dynamics Panel of AGARD held a round-table discussion of the fluid dynamic aspect of icing. This took place following the FDP Symposium on Unsteady Aerodynamics in Ottawa, Canada on the 30th of September, 1977. Papers are presented on the following topics: (1) recent results on icing parameters, (2) helicopter ice detection, icing severity and liquid water content measurement, (3) icing trails on the front fuselage and engine intake of helicopters at conditions simulating forward flight, (4) ice accretion and its effects on aerodynamics of unprotected aircraft components, (5) a theoretical and experimental means to predict ice accretion shapes for evaluating aircraft handling and performance characteristics and (6) icing test facilities and techniques in Europe.

N79-15038# National Research Council of Canada Ottawa (Ontario) Div of Mechanical Engineering
HELICOPTER ICE DETECTION, ICING SEVERITY AND LIQUID WATER CONTENT MEASUREMENTS

J R Stallabrass In AGARD Aircraft Icing Nov 1978 7 p refs Avail NTIS HC A07/MF A01

Icing detection on a helicopter presents difficulties because of the wide relative speed range from hover to maximum cruise. High detection sensitivity is necessary at any flight speed because of the high susceptibility of the rotor blades to the effects of even quite small ice accretion. An icing detector is described that largely overcomes the problem of speed dependence and thus permits the determination of icing rate and cloud liquid water content with reasonable accuracy. G Y

N79-15039# National Gas Turbine Establishment Pyestock (England) Engine Test Dept
ICING TRIALS ON THE FRONT FUSELAGE AND ENGINE INTAKES OF HELICOPTERS AT CONDITIONS SIMULATING FORWARD FLIGHT

P F Ashwood and R D Swift In AGARD Aircraft Icing Nov 1978 16 p refs

Avail NTIS HC A07/MF A01

One of the large test chambers of the Altitude Test Facility at the NGTE was successfully used for full-scale trials on the

front fuselage and engine intakes of the Westland Sea King and the Westland/Aerospatiale Lynx helicopters under simulated wet icing conditions. The paper describes tests made to examine the effects of air temperature, air speed, water concentration and aircraft attitude on the extent of ice accretion. The possibility of ice ingestion by the engines during melt-off was also studied using high-speed videotape recordings. Data are also presented from non-rotating tests on full-scale sections of main rotor blade made to examine the effects on accretion of bladespeed, pitch angle, air temperature and water concentration. The effects of cyclic pitch change have also been examined and typical results are presented. The paper includes general comments on the use of an altitude cell for helicopter icing investigations and the accumulation of data leading to clearance for flight in icing conditions.

Author

N79-15040# Messerschmidt-Boelkow G m b H Ottobrunn (West Germany)

ICE ACCRETION AND ITS EFFECTS ON AERODYNAMICS OF UNPROTECTED AIRCRAFT COMPONENTS

Boris Laschka and Rudolf E Jesse. In AGARD Aircraft Icing Nov 1978 22 p refs

Avail NTIS HC A07/MF A01

A survey is given on theoretical and experimental methods applied to determine the ice accretion and its effects on the respective aerodynamics on unprotected components of a modern jet transport aircraft. Together with an introductory outline of the mechanism and the basic mathematical equations and correlations ruling ice generation, the experience obtained for the European Airbus A300 is used to describe these methods. In addition, an example for the prediction of trajectories of shedding ice particles as applied for the German jet transport aircraft VFW 614 is given.

Author

N79-15041# Boeing Co Seattle Wash

A THEORETICAL AND EXPERIMENTAL MEANS TO PREDICT ICE ACCRETION SHAPES FOR EVALUATING AIRCRAFT HANDLING AND PERFORMANCE CHARACTERISTICS

Ramon W Wilder. In AGARD Aircraft Icing Nov 1978 20 p refs

Avail NTIS HC A07/MF A01

To determine the need for airfoil ice protection systems and the effects of large ice shapes on airplane performance, a research program was initiated to obtain basic ice accretion and ice shedding data on typical jet transport airfoils. An empirical relationship derived from basic airfoil water catch parameters was used to correlate measured ice accretion rates with theoretical water impingement parameters. This correlation used glaze ice heights and angles measured from the plaster casts of the actual ice shapes as taken from the two swept airfoil test models. Results of this correlation show that ice accretion characteristics are dependent on airfoil shape, particularly leading edge radius, camber and angle of attack. Complex trends of the data obtained in this test program precluded a general ice accretion relationship with other airfoils. Additional testing of other airfoil shapes and angle of attack would provide for broader application of the ice cap calculation procedures developed herein. Airplane performance penalties associated with icing in terms of landing weight penalties, and when these penalties are assessed are also discussed. Destination airport temperatures and ice shedding characteristics are shown to be significant in determining the frequency of aerodynamic penalties due to ice.

Author

N79-15042# Office National d'Etudes et de Recherches Aerospatiales, Paris (France)

ICING TEST FACILITIES AND TEST TECHNIQUES IN EUROPE

Marcel Pierre and Xavier Vaucheret. In AGARD Aircraft Icing Nov 1978 23 p refs

Avail NTIS HC A07/MF A01

Icing techniques performed at various test facilities in Europe are described. The locations of the facilities are given with

special emphasis on the Onera Modane center for icing tests. Problems encountered in performing artificial icing tests in wind tunnels are discussed.

LS

N79-15043# National Research Council of Canada Ottawa (Ontario) Div of Mechanical Engineering

ICING TEST FACILITIES IN CANADA

T R Ringer. In AGARD Aircraft Icing Nov 1978 12 p refs

Avail NTIS HC A07/MF A01

The icing simulation facilities for research, development and testing at the National Research Council of Canada are described. The major facilities include a low speed icing wind tunnel, a high speed variable density tunnel, a refrigerated jet engine test cell and a helicopter icing spray rig. An Appendix is included that lists reports and papers published on icing since 1935.

Author

N79-15044*# National Aeronautics and Space Administration Langley Research Center Hampton Va

THE LOOK-POINT AIRCRAFT COORDINATE ESTIMATOR (LACE) AND POTENTIAL APPLICATIONS

Willard W Anderson. Jan 1979 16 p ref (NASA-TM-78806) Avail NTIS HC A02/MF A01 CSCL 01D

A look-point aircraft coordinate estimator (LACE) consisting of a windshield runway symbol projector, pilot input controls, microprocessor and eye-alignment device is described. The estimator is used by a pilot to determine his aircraft's position relative to a runway or other visible terrain or target. The pilot initially superimposes and then corrects the superposition of the runway symbol over the runway during approach during periods when the runway is visible. Using the pilot's inputs, the microprocessor calculates the position of the aircraft in terms of runway coordinates, then generates an approach trajectory and issues instructions to an autopilot. The microprocessor contains a model of the aircraft's dynamics and calculates a theoretical aircraft trajectory. The theoretical position of the aircraft is then used to drive the runway symbol with the pilot's input being additive. The system thus acts as an aid in making low visibility approaches and landings when only an occasional glimpse of the runway is possible and no ground referenced landing systems are available. The system can also be used as an independent landing monitor for ground referenced landing systems.

JMS

N79-15045*# AirResearch Mfg Co Los Angeles Calif

THERMAL-STRUCTURAL DESIGN STUDY OF AN AIRFRAME-INTEGRATED SCRAMJET. Interim Summary Report, Jun 1975 - Mar 1977

J J Killackey, E A Katinsky, S Tepper and A A Vuigner. Dec 1978 126 p refs

(Contract NAS1-13984)

(NASA-CR-145368, AirResearch-77-13967) Avail NTIS HC A07/MF A01 CSCL 21A

Design concepts are developed and evaluated for a cooled structures assembly for the Scramjet engine, for engine subsystems mass, volume, and operating requirements, and for the aircraft/engine interface. A thermal protection system was defined that makes it possible to attain a life of 100 hours and 1000 cycles. The coolant equivalence ratio at the Mach 10 maximum thermal loading condition is 0.6, indicating a capacity for airframe cooling. The mechanical design is feasible for manufacture using conventional materials. For the cooled structures in a six-module engine, the mass per unit capture area is 12.4 KN/sq m. The total weight of a six-module engine assembly including the fuel system is 14.73 KN.

GG

N79-15046*# Boeing Military Airplane Development Seattle, Wash

A METHOD TO ESTIMATE WEIGHT AND DIMENSIONS OF LARGE AND SMALL GAS TURBINE ENGINES. Final Report

E Onat and G W Klees. Jan 1979 136 p refs

(Contract NAS3-21205)

(NASA-CR-159481) Avail NTIS HC A07/MF A01 CSCL 21E

A computerized method was developed to estimate weight and envelope dimensions of large and small gas turbine engines within + or - 5% to 10%. The method is based on correlations of component weight and design features of 29 data base engines. Rotating components were estimated by a preliminary design procedure which is sensitive to blade geometry operating conditions material properties shaft speed hub tip ratio etc. The development and justification of the method selected, and the various methods of analysis are discussed B B

N79-15048*# National Aeronautics and Space Administration
Lewis Research Center, Cleveland, Ohio
NASA THERMAL BARRIER COATINGS SUMMARY AND UPDATE

Francis S Stepka 1978 23 p refs Presented at Proj SQUID (ONR) Workshop on Cooling Problems in Aircraft Gas Turbines Monterey Calif 27-28 Sep 1978, sponsored by AFOSR Naval Air Systems Command and ONR (NASA-TM-79053, E-9862) Avail NTIS HC A02/MF A01 CSCL 21E

A durable two-layer, plasma-sprayed coating consisting of a ceramic layer over a metallic layer was developed that has the potential of insulating hot engine parts and thereby reducing metal temperatures and coolant flow requirements and/or permitting use of less costly and complex cooling configurations and materials. The results are summarized of analytical and experimental investigations of the coatings on flat metal specimens turbine vanes and blades, and combustor liners. Discussed are results of investigations to determine coating adherence and durability coating thermal, strength and fatigue properties and chemical reactions of the coating with oxides and sulfates. Also presented are the effect of the coating on aerodynamic performance of a turbine vane, measured vane and combustor liner temperatures with and without the coating and predicted turbine metal temperatures and coolant flow reductions potentially possible with the coating. Included also are summaries of some current research related to the coating and potential applications for the coating Author

N79-15049*# National Aeronautics and Space Administration
Lewis Research Center, Cleveland, Ohio
EFFECT OF FORWARD VELOCITY AND CROSSWIND ON THE REVERSE-THRUST PERFORMANCE OF A VARIABLE-PITCH FAN ENGINE

D C Reemsnyder and D A Sagerser 17 Jan 1979 21 p refs Presented at the 17th Aerospace Sci Meeting, New Orleans 15-17 Jan 1979, sponsored by Am Inst of Aeron and Astronautics (NASA-TM-79059, E-9873, AIAA-79-0105) Avail NTIS HC A02/MF A01 CSCL 21E

A full-size variable-pitch fan engine was tested in the Ames 40 by 80 foot wind tunnel to determine the effect of forward velocity and crosswind on reverse-thrust performance. Two flight-type inlet configurations were tested, and a flared fan nozzle was installed as an inlet for reverse-thrust operation. Steady-state reverse-thrust performance was obtained up to 54 m/s (105 knots). An abrupt decrease in reverse thrust occurred at about 30 m/s (60 knots). Reverse thrust was established following forward-to-reverse thrust transients both statically and with forward velocities only up to 30 m/s Author

N79-15050*# National Aeronautics and Space Administration
Lewis Research Center, Cleveland, Ohio
THE NASA HIGH PRESSURE FACILITY AND TURBINE TEST RIG

Francis S Stepka 1978 17 p refs Presented at the Project SQUID (ONR) Workshop on Cooling Probl in Aircraft Gas Turbines Monterey, Calif, 27-28 September 1978, sponsored by AFOSR Naval Air Systems Command, and ONR (NASA-TM-79054 E-9863) Avail NTIS HC A02/MF A01 CSCL 21E

A description of the facility and turbine test rig is presented. Also discussed is the turbine cooling test program L S

N79-15051*# National Aeronautics and Space Administration
Lewis Research Center Cleveland, Ohio

PRELIMINARY QCGAT PROGRAM TEST RESULTS

R W Koenig and G K Sievers 1979 19 p refs To be presented at the Business Aircraft Meeting Wichita Kas 3-6 Apr 1979 sponsored by SAE (NASA-TM-79013 E-9802) Avail NTIS HC A02/MF A01 CSCL 21E

NASA Lewis Research Center is conducting a program to demonstrate that large commercial engine technology can be applied to general aviation engines to reduce noise emissions and fuel consumption and to develop new technology where required. The overall engine program, design and technology incorporated into the QCGAT engines are described. In addition preliminary engine test results are presented and compared to the technical requirements the engines were designed to meet S E S

N79-15052*# Teledyne Continental Motors, Mobile Ala
COMPUTER SIMULATION OF AN AIRCRAFT ENGINE FUEL INJECTION SYSTEM Final Report

David D Hester Jun 1978 93 p refs (Contracts NAS3-19755 DOT-FA74NA-1091) (NASA-CR-157641 AD-A060452, FAA-NA-78-156, FAA-RD-78-67) Avail NTIS HC A05/MF A01 CSCL 21/7

An analytical model of the Teledyne Continental fuel system was studied to provide a basis for quantitatively exploring deficiencies in the system response which lead to poor exhaust emission characteristics. A computer model of the fuel system was developed based on component testing and found to give accurate predictions for pressures and flow rates within the system. The model was used to investigate modifications to the system for improved fuel management and reduced exhaust emissions. The effect of improved fuel management on engine exhaust emissions is evaluated F O S

N79-15053*# General Electric Co Evendale, Ohio Aircraft Engine Business Group
ANALYSIS AND PRELIMINARY DESIGN OF AN OPTICAL DIGITAL TIP CLEARANCE SENSOR FOR PROPULSION CONTROL

G L Poppel Sep 1978 28 p (Contract NAS3-21006) (NASA-CR-159434 R78AEG518) Avail NTIS HC A03/MF A01 CSCL 21E

Following the generation of several concepts for passive, digital compatible optical sensors for propulsion control systems a tip clearance sensor was chosen for further analysis and preliminary design. Emphasis was placed on application to the TF34 engine compressor section. Laboratory experiments were performed to investigate several optical aspects of the concept. Preliminary design included an assessment of all sensor elements and recommendations for development programs. Quantitative predictions were made of sensor performance. A test plan was written to demonstrate sensor feasibility and that the performance goals can be met. A continuing experimental and design effort was suggested Author

N79-15054# Scott Environmental Technology, Inc. Plumsteadville, Pa

J57-59W ENGINE EMISSION TEST REPORT Final Report, Nov 1978 - Dec 1977

Anthony F Souza and Harold A Scott, Jr Tyndall AFB, Fla Civil and Environmental Engineering Development Office Jul 1978 92 p (Contract F08635-77-C-0216)

(AD-A060842 SET-1628-02-1177 CEEDO-TR-78-37) Avail NTIS HC A05/MF A01 CSCL 21/5

The exhaust emissions from three J57-59W water injected turbojet engines were measured. Emission rates of hydrocarbons, carbon monoxide and oxides of nitrogen were calculated. Smoke opacity and particulate loading were also measured. Best estimate emission factors are presented Author (GRA)

N79-15055# Rockwell International Corp, Columbus, Ohio
Aircraft Div
**VISCID/INVISCID INTERACTION ANALYSIS OF THRUST
AUGMENTING EJECTORS** Interim Report, 1 Jun 1977 -
28 Feb 1978

P M Bevilacqua and A D DeJode 28 Feb 1978 55 p refs
(Contract N00014-77-C-0271 RF41411801)
(AD-A059546, NR78H-21, ONR-CR212-249-1) Avail NTIS HC
A04/MF A01 CSCL 21/5

A method has been developed for calculating the static performance of thrust augmenting ejectors by matching a viscous solution for the flow through the ejector to an inviscid solution for the flow outside the ejector. In effect, the ejector shroud is considered to be 'flying' in the secondary velocity field induced by the entrainment of the primary jets. A two-dimensional analysis utilizing a turbulence kinetic energy model for the inner, jet mixing solution and potential flow singularities for the outer, induced flow is described. This approach offers the advantage of including external influences on the flow through the ejector. Comparisons with data are presented for an ejector having a single central nozzle and Coanda jets on the walls. The accuracy of the matched solution is found to be especially sensitive to the jet flap effect of the flow just downstream of the ejector exit. Author (GRA)

N79-15056# Environmental Protection Agency Ann Arbor Mich
Standards Development and Support Branch

**COST EFFECTIVENESS ANALYSIS OF THE PROPOSED
REVISIONS IN THE EXHAUST EMISSION STANDARDS FOR
NEW AND IN-USE GAS TURBINE AIRCRAFT ENGINES
BASED ON EPA'S INDEPENDENT ESTIMATES**

Richard S Wilcox and Richard W Munt Feb 1978 50 p
refs
(PB-286388/4, AC-78-01) Avail NTIS HC A03/MF A01 CSCL
01C

To determine the most efficient means of achieving the national ambient air quality standards, the cost effectiveness of various pollution abatement control strategies were compared and the most effective were implemented. A cost effectiveness analysis of the proposed revisions in exhaust emission standards for aircraft gas turbine engines using EPA's independent cost estimate is presented. GRA

N79-15057*# National Aeronautics and Space Administration
Langley Research Center, Hampton, Va
COMPENSATING LINKAGE FOR MAIN ROTOR CONTROL
Patent Application

Phillip A Jeffery (Sikorsky Aircraft Div Stratford Conn) and
Rudolf F Huber inventors (to NASA) Filed 15 Dec 1978
17 p. Sponsored by NASA
(NASA-Case-LAR-11797-1 US-Patent-Appl-SN-969755) Avail
NTIS HC A02/MF A01 CSCL 01C

A helicopter rotor control system is described which will automatically compensate for unwanted signal inputs due to relative movement between an airframe structure and a rotor and transmission which is isolated from the airframe structure by a hydraulic cushion. The rotor control signal is transmitted to a summing linkage by means of a control rod. The summing linkage moves the inner rod by an amount proportional to the control signal which in turn adjusts the actuating rod by means of a bellcrank. The relative motion of transmission is passed to the outer compensating rod by a bracket. The compensating rod adjusts a summing link which moves the inner rod by an amount proportional to the relative motion of transmission. Thus relative motion of transmission is prevented from moving the actuator rod and sending false control signals to the hydraulic actuators which change the pitch of the helicopter rotor blades. NASA

N79-15058# Princeton Univ, N J Flight Research Lab
**A STUDY OF LONGITUDINAL CONTROLLABILITY AND
STABILITY REQUIREMENTS FOR SMALL GENERAL
AVIATION AIRPLANES** Final Report

David R Ellis and Cornelius L Griffith 3 Aug 1978 145 p

refs

(Contract DOT-FA75WA-3679)
(AD-A060467, AMS-1369, FAA-RD-78-113) Avail NTIS
HC A07/MF A01 CSCL 01/3

Several aspects of small airplane longitudinal stability and control were examined by means of analysis and in-flight simulation experiments. The influence of various levels of static stability in the context of approach landing, and climb tasks was studied, with particular emphasis on the effects of force gradient augmentation by means of downsprings. Cases in which spring force varied with elevator deflection or with angle of attack were considered in addition to the classical constant-force type. Constant-force or increasing force with up-elevator springs were favored when the preferred natural (no device) gradient was not available. Maneuvering stability tests focused on the effects of departure from linear force vs normal acceleration characteristics, a local reduction in slope of 50 percent was detectable but considered to be acceptable. Author

N79-15059# Rockwell International Corp Columbus Ohio
Aircraft Div

**FLIGHT VERIFICATION OF THE ADVANCED FLIGHT
CONTROL ACTUATION SYSTEM (AFCAS) IN THE T-2C
AIRCRAFT** Final Report, 30 Jun 1976 - 30 Jun 1978

Joseph N Demarchi and Robert K Haning Aug 1978 144 p
refs
(Contract N62269-76-C-0201)

(AD-A060326, NR78H-36 NADC-75287-60) Avail NTIS
HC A07/MF A01 CSCL 01/3

The feasibility of the Advanced Flight Control Actuation System (AFCAS) concept was demonstrated in a T-2C aircraft. The test installation contained a localized 8000 psi (55 MPa) hydraulic power supply, control-by-wire direct-drive modular design rudder actuator electronic drive unit and force transducer. The system performed exceptionally well during 102 hours of flight evaluation. Successful completion of this project confirmed prior analyses and laboratory testing. Author (GRA)

N79-15060# ARO, Inc Arnold Air Force Station Tenn
**SENSITIVITY OF AIRCRAFT SPINNING MOTION TO
DYNAMIC CROSS-COUPLING AND ACCELERATION
DERIVATIVES** Final Report, 1 Oct 1976 - 30 Sep 1977

R W Butler and T F Langham Oct 1978 48 p refs
(AD-A060516 AEDC-TR-78-12) Avail NTIS
HC A03/MF A01 CSCL 01/2

An investigation was conducted to provide an insight into the importance of dynamic cross-coupling and acceleration derivatives in the spinning motion of fighter aircraft. The basic spinning motion of two aircraft was generated with a six-degree-of-freedom motion simulation program. The dynamic cross-coupling and acceleration derivatives were input into the program both individually and simultaneously to note their effect on the time history of spinning motion. Results of the study indicate that the dynamic derivatives can produce significant effects on the aircraft spinning motion and should be considered when conducting a spin analysis. The study also indicates that the spinning motion sensitivity to the dynamic cross-coupling and acceleration derivatives investigated is configuration dependent. GRA

N79-15061# Advisory Group for Aerospace Research and
Development, Neuilly-Sur-Seine (France)

DYNAMIC STABILITY PARAMETERS

Nov 1978 623 p refs In ENGLISH and FRENCH Symp
held in Athens 22-24 May 1978
(AGARD-CP-235 ISBN-92-835-0223-X) Avail NTIS
HC A99/MF A01

The mission of AGARD is to bring together the leading personalities of the NATO nations in the fields of science and technology relating to aerospace. This symposium was organized in recognition of the strong present-day interest in dynamic stability of aerospace vehicles. The purpose of the symposium was to discuss the specific needs for dynamic stability information the form in which it should be presented and the various means of

obtaining it The symposium was divided into the following sessions (1) wind tunnel techniques 1 (2) wind tunnel techniques 2, (3) flight testing techniques (4) analytical techniques (5) motion analysis and nonlinear formulations (6) sensitivity and simulator studies and (7) workshop session

N79-15062# National Aeronautical Establishment Ottawa (Ontario) Unsteady Aerodynamics Lab

TECHNIQUES FOR DYNAMIC STABILITY TESTING IN WIND TUNNELS

K J Orlik-Rueckemann /in AGARD Dyn Stability Parameters Nov 1978 24 p refs

Avail NTIS HC A99/MF A01

A systematic review is presented of the methods and techniques that are used for wind tunnel measurements of the dynamic stability parameters (derivatives) of an aircraft The review is illustrated by numerous examples of experimental equipment available in various aerospace laboratories in Canada, France the United Kingdom, the United States and West Germany G Y

N79-15063# Institut de Mecanique des Fluides de Lille (France)
A NEW METHOD FOR TESTING FREE MODELS IN THE LABORATORY TO DETERMINE AERODYNAMIC CHARACTERISTICS [NOUVELLE TECHNIQUE D'ESSAIS SUR MAQUETTES LIBRES EN LABORATOIRE POUR LA DETERMINATION DE CARACTERISTIQUES AERODYNAMIQUES]

W Charon and R Verbrugge /in AGARD Dyn Stability Parameters Nov 1978 26 p In FRENCH

Avail NTIS HC A99/MF A01

A methodology relating to the study on free flight models under laboratory conditions linked with flight control was outlined Experimental technique was put into operation in the area of work concerning the regulation of lift by rapid moving flaps on transport aircraft Unstable aerodynamic coefficients were identified, and some of the following aspects of the testing technique were developed (1) theory and experimental method, (2) structural analysis of test models and (3) measure and treatment of unstable data Transl by B B

N79-15064*# National Aeronautics and Space Administration Ames Research Center Moffett Field Calif

NEW NASA-AMES WIND-TUNNEL TECHNIQUES FOR STUDYING AIRPLANE SPIN AND TWO-DIMENSIONAL UNSTEADY AERODYNAMICS

Gerald N Malcolm and Sanford S Davis /in AGARD Dyn Stability Parameters Nov 1978 12 p refs

Avail NTIS HC A99/MF A01 CSCL 01C

Two new wind tunnel test apparatuses were developed at NASA-Ames Research Center The first is a rotary-balance apparatus to be used in the Ames 12-Foot Pressure Tunnel for investigating the effects of Reynolds number spin rate and angle of attack on the aerodynamics of fighter and general aviation aircraft in a steady spin motion The second apparatus provides capability for oscillating a large two dimensional wing (0.5 m chord 1.35 m span) instrumented with steady and unsteady pressure transducers in the Ames 11 x 11 ft Transonic Wind Tunnel A complete description of both apparatuses their capabilities and some typical wind tunnel results are presented G Y

N79-15066# Technische Universitaet, Darmstadt (West Germany)

WIND TUNNEL TESTING OF DYNAMIC DERIVATIVES IN WEST GERMANY

X Hafer /in AGARD Dyn Stability Parameters Nov 1978 12 p refs

Avail NTIS HC A99/MF A01

A survey of the activities of the German national working group engaged in the development of dynamic wind tunnel test installations is given The development of four different test rigs

was planned So far the development of three test rigs is complete Each rig was designed to meet very specific test requirements which are discussed in detail Test results are presented giving a comparison of systematic tests with the same model mounted on different test rigs in different wind tunnels Some flight test results of the corresponding original plane are compared In addition some results of linearized flight dynamic investigations are presented to demonstrate the influence of the several dynamic derivatives on the longitudinal and lateral aircraft dynamics G Y

N79-15067# Dornier-System G m b H Friedrichshafen (West Germany)

ON THE TEST PROCEDURES OF THE DERIVATIVE BALANCES USED IN WEST GERMANY

Jan VonderDecken Eberhard Schmidt (DFVLR, Braunschweig, West Germany) and Bernd Schulze (Messerschmitt-Boelkow-Blohm G m b H Munich, West Germany) /in AGARD Dyn Stability Parameters Nov 1978 17 p refs

Avail NTIS HC A99/MF A01

The low-speed wind tunnels in West-Germany are equipped with three different test installations to measure dynamic stability derivatives on rigid models of aeroplanes and missiles (1) a mobile oscillatory apparatus with inexorable mechanical drive, (2) a multi-degree-of-freedom forced-oscillation apparatus with electrodynamic excitation (3) a steady-state forced-roll apparatus with hydraulic motor drive A short description of the measuring technique and the appropriate derivative evaluation method used with each installation is given G Y

N79-15068# National Aeronautical Establishment, Ottawa (Ontario) Unsteady Aerodynamics Lab

EXPERIMENTS ON CROSS-COUPLING AND TRANSLATIONAL ACCELERATION DERIVATIVES

K J Orlik-Rueckemann and E S Hanff /in AGARD Dyn Stability Parameters Nov 1978 8 p refs

Avail NTIS HC A99/MF A01

Categories of dynamic stability problems are discussed that are of particular importance for aircraft flying at high angles of attack or at non-zero sideslip angles These encompass the static and dynamic cross-coupling effects between the lateral and the longitudinal degrees of freedom the strong nonlinear effects at high angles of attack and the effects of translational acceleration Experimental techniques developed to determine these effects are briefly described and some illustrative examples of the measured cross-coupling and acceleration derivatives are presented G Y

N79-15070# Office National d Etudes et de Recherches Aeronautiques, Paris (France)

DETERMINING THE NONLINEARITIES OF DYNAMIC STABILITY [DETERMINATION DE NON-LINEARITES DE STABILITE DYNAMIQUE]

Xavier Vaucheret /in AGARD Dyn Stability Parameters Nov 1978 14 p refs In FRENCH

Avail NTIS HC A99/MF A01

Aside from classical theories of nonlinear mechanics a classification of nonlinearity based on their effects was proposed Two concrete cases of strong nonlinear oscillations one which contains a limited cycle, illustrate the methods developed

Transl by B B

N79-15071# Messerschmitt-Boelkow-Blohm G m b H Munich (West Germany)

SOME FACTORS AFFECTING THE DYNAMIC STABILITY DERIVATIVES OF A FIGHTER-TYPE MODEL

W Staudacher B Laschka, B Schulze, P Poisson-Quinton (ONERA Modane France), and M Canu (ONERA, Modane, France) /in AGARD Dyn Stability Parameters Nov 1978 13 p refs

Avail NTIS HC A99/MF A01

In the course of a Franco-German cooperation dynamic stability coefficients of a fighter-type pilot model were derived

experimentally In a first step forced oscillation tests were carried out The angle of attack regime investigated was $\alpha = 0 + 25$ degrees This first test phase concentrated on the investigation of the effects of a strakes, on the total derivatives of the configuration Emphasis of a further second test period are put on configurational items as strakes flap systems tails, etc and experimental characteristics as Reynolds number frequency and amplitudes G Y

N79-15073# Bristol Univ (England) Dept of Aeronautical Engineering

UNSTEADY AERODYNAMICS OF OSCILLATING CONTAINERS AND APPLICATION TO THE PROBLEM OF DYNAMIC STABILITY OF HELICOPTER UNDERSLUNG LOADS

A Simpson and J W Flower In AGARD Dyn Stability Parameters Nov 1978 33 p refs

Avail NTIS HC A99/MF A01

Loads slung beneath helicopters can develop alarming oscillations at quite low airspeeds due to aerodynamic forces, and hence severely curtail the performance of the helicopter The investigation highlights the (sometimes overriding) importance of load movement on the aerodynamic forces for the particular case of the standard 20 x 8 x 8 foot container Forces and moments were derived from pressure measurements on two models, inexorably oscillated in a variety of modes and at various amplitudes with some comparison with other results from decaying oscillation investigations Extreme nonlinearities are evident Flow visualization techniques show complex flow situations and extreme phase lags in the separated flow patterns A mathematical model based on the observed patterns compares well with the force and moment results G Y

N79-15074# Air Force Flight Test Center Edwards AFB, Calif
AIR FORCE FLIGHT TEST CENTER EXPERIENCE IN THE IDENTIFICATION OF STABILITY AND CONTROL PARAMETERS FROM DYNAMIC FLIGHT TEST MANEUVERS

Paul M Jeglum In AGARD Dyn Stability Parameters Nov 1978 5 p refs

Avail NTIS HC A99/MF A01

Air Force Flight Test Center experience in the flight test determination of stability derivatives is generalized in terms of the attainment of known benefits and the practical and philosophical necessity for the use of the technique are discussed Data from recent flight test programs is used to illustrate that Stability Derivative Extraction (STABDEX) techniques result in savings of flight time, a significantly better and safer flight test program and high quality data which would otherwise be unobtainable Concluding remarks discuss the importance of the technique for the flight testing of advanced designs G Y

N79-15075# National Aeronautics and Space Administration
Hugh L Dryden Flight Research Center, Edwards Calif
ESTIMATION OF AERODYNAMIC CHARACTERISTICS FROM DYNAMIC FLIGHT TEST DATA

Kenneth W Liff In AGARD Dyn Stability Parameters Nov 1978 26 p refs

Avail NTIS HC A99/MF A01

Significant effort was spent in estimating unknown aircraft coefficients such as stability and control derivatives from dynamic flight maneuvers The techniques used to estimate these coefficients are becoming increasingly complex, however, these techniques make it possible to obtain estimates of coefficients that in the past were nearly impossible to obtain A survey of the investigations that were undertaken to obtain estimates of coefficients from dynamic flight maneuvers is presented One method the maximum likelihood estimation technique, is described briefly and some of the successful applications of the technique are presented Possible techniques for analyzing responses obtained in the stall/spin regime are discussed Recent data obtained in the stall/spin flight regime are presented along with a discussion of how some basic results can be obtained with simple analysis techniques G Y

N79-15076# Air Force Flight Dynamics Lab, Wright-Patterson AFB Ohio

AERODYNAMIC INTERACTIONS ON THE FIGHTER CCV TEST AIRCRAFT

Robert A Whitmoyer In AGARD Dyn Stability Parameters Nov 1978 13 p refs

Avail NTIS HC A99/MF A01

The Fighter CCV YF-16 testbed aircraft completed an 87 flight 125 hour test program in June 1977 The aircraft achieved higher levels of direct force control that had previously been flight tested The direct force capabilities were used to implement six unconventional control modes on the aircraft, consisting of flat-turns, decoupled normal acceleration control independent longitudinal and lateral translations, and uncoupled elevation and azimuth aiming The flight test program and supporting wind tunnel testing produced a wealth of data concerning the complex aerodynamic interactions between the force and moment producers on a Control Configured Vehicle design The interactions were prime factors in determining the viability of the unconventional control concepts investigated G Y

N79-15077# Calspan Corp, Buffalo, N Y Flight Sciences Dept

IDENTIFICATION OF THE STABILITY PARAMETERS OF AN AEROELASTIC AIRPLANE

Edmund G Rynaski, Dominick Andrisani II and Norman Weingarten In AGARD Dyn Stability Parameters Nov 1978 9 p refs Sponsored in part by NASA Langley Res Center

(Contract F33615-73-C-3051)

Avail NTIS HC A99/MF A01 CSCL 01C

The problem of the parameter identification of large scale dynamic systems involving a system matrix characterized by approximately 200 elements is addressed By using phase variable transformations, a mathematical model of an aeroelastic airplane is described in a form that is amenable to partial or piecemeal acceptance of parameters estimated from flight data A mathematical model of the US Air Force Total In-Flight Simulator was computed using the FLEXSTAB digital computer program As data became available during the progress of the flight test program, this data was processed and substituted in the mathematical model for parameters analytically obtained from the FLEXSTAB program The results tend to show a progressive and orderly transition from an analytically defined mathematical model to one obtained from the flight tests of the actual aircraft G Y

N79-15078# Boeing Commercial Airplane Co Renton Wash
NONLINEAR PARAMETER IDENTIFICATION AND ITS APPLICATION TO TRANSPORT AIRCRAFT

T J Galbraith and T J Petersen In AGARD Dyn Stability Parameters Nov 1978 20 p refs

Avail NTIS HC A99/MF A01

A nonlinear parameter identification computer program and results obtained from analyzing jet transport flight data characterized by nonlinear motion and parameters is described The program is called NLAK for nonlinear aerodynamics and kinematics and is part of a system of computer programs for analyzing airplane dynamic response data NLAK's formulation is based on the full six degrees-of-freedom equations of motion and up to third order polynomials for aerodynamic coefficients and thrust parameters NLAK employs a maximum likelihood estimation algorithm which is capable of both recursive and batch processing The flight data analyzed was low speed below 150 knots The analysis system is outlined and all interfaces with the NLAK program are described The basic concepts and some of NLAK's formulation details are also described in relation to obtaining consistent estimation results especially for the nonlinear problem G Y

N79-15079# Northrop Corp Hawthorne Calif Aerosciences Research Dept

A SURVEY OF ANALYTICAL AND EXPERIMENTAL TECHNIQUES TO PREDICT AIRCRAFT DYNAMIC CHARACTERISTICS AT HIGH ANGLES OF ATTACK

A M Skow and A Titiriga Jr /in AGARD Dyn Stability Parameters Nov 1978 37 p refs

Avail NTIS HC A99/MF A01

A survey of some of the techniques that will aid the fighter aircraft designer in building good high angle-of-attack aerodynamic characteristics into the airframe is presented. Some of the more well known analytical and experimental methods and endeavors to highlight the contributions each method provides are summarized. G Y

N79-15080# Messerschmitt-Boelkow-Blohm G m b H Munich (West Germany)

PRESENTATION OF STABILITY DERIVATIVES IN MISSILE AERODYNAMICS AND THEORETICAL METHODS FOR THEIR PREDICTION

C P Schneider /in AGARD Dyn Stability Parameters Nov 1978 31 p refs

Avail NTIS HC A99/MF A01

Analytical procedures are indicated for the determination of pitching derivatives and coefficients essentially of arbitrary planform wings of bodies of revolution and of combinations in the linear and nonlinear angle-of-attack range in subsonic and supersonic flow. A frame of classification of theory for missile design in particular is prepared due to the abundance of unsteady flow problems. The methods for the prediction of pitching derivatives and for solving stability problems arising with longitudinal acceleration of missile are described. Results indicate the importance of derivatives with respect to missile stability. S E S

N79-15081# National Aerospace Lab Amsterdam (Netherlands)
THE USE OF PANEL METHODS FOR STABILITY DERIVATIVES

R Roos /in AGARD Dyn Stability Parameters Nov 1978 11 p refs

Avail NTIS HC A99/MF A01

The possibilities of panel methods for computing aerodynamic stability derivatives are reviewed. Reasons were given why not all derivatives especially those which are dominated by viscous drag can be computed with the same level of accuracy. The unsteady panel methods developed for aeroelastic applications, were shown to be very useful for computing dynamic stability derivatives. The value of such methods was demonstrated with the aid of some computed examples compared with experimental data. S E S

N79-15082# Waterloo Univ (Ontario) Dept of Applied Mathematics

AN ANALYTIC THEORY OF SUPERSONIC/HYPERSONIC STABILITY AT HIGH ANGLES OF ATTACK

W H Hui /in AGARD Dyn Stability Parameters Nov 1978 9 p refs

Avail NTIS HC A99/MF A01

The problem of dynamic stability is studied based on inviscid flow theory. The amplitude and frequency of the pitching oscillation are assumed small and a perturbation method employed. Systematic investigations of the closed form analytic formulae for the stability derivatives of oscillating wedges, flat plates, delta wings (with attached shock waves or detached shock waves) lead to the following general conclusions: (1) increasing flight Mach number M sub infinity tends to increase the dynamic stability and the stability derivatives tend to constant for large M sub infinity; (2) the sweep-back angle of a delta wing has only small effects on its dynamic stability; (3) for small angles of attack α , the damping-in-pitch derivative increases with α but after α reaches certain critical angle the trend is reversed and further increase in α may rapidly cause dynamical instability; and (4) the effects of the specific heat ratio γ of the gas on dynamical stability are small for small angles of attack α but are large for large α and in the latter case increasing γ can also cause dynamic instability. S E S

N79-15083# Adjutant General Center, Washington D C
IDENTIFICATION OF UNSTEADY EFFECTS IN LIFT BUILDUP

P Mereau, R Hirsch, G Coulon, and A Rault /in AGARD Dyn Stability Parameters Nov 1978 14 p refs

Avail NTIS HC A99/MF A01

A methodology to identify unsteady aerodynamic forces from flight test data is proposed and developed in the case of uncoupled longitudinal motion. This method includes several steps based upon linearity and frequency separation: data filtering, classical stability and control parameters identification, transient forces estimation, unsteady terms identification. The mathematical model includes state equations and convolution integrals, thus requiring particular identification algorithms well adapted to each form of representation. The results obtained in the case of non-powered flights of a reduced scale plane are very satisfactory in the sense that their comparison with existing theoretical developments are very close and thus validate the theoretical characterizations. S E S

N79-15084# Lockheed Missiles and Space Co., Sunnyvale Calif

EFFECT OF FLOW SEPARATION VORTICES ON AIRCRAFT UNSTEADY AERODYNAMICS

L E Ericsson and J P Reding /in AGARD Dyn Stability Parameters Nov 1978 12 p refs

(Contracts NAS8-28130, NAS8-30652, NAS9-11445)

Avail NTIS HC A99/MF A01 CSCL 01C

The unsteady aerodynamic flow field over the space shuttle orbiter was studied. The results indicate at moderate to high angles of attack separation-induced vortices exert a dominating influence on the unsteady aerodynamics of the space shuttle orbiter and of high performance aircraft. The main characteristics are as follows: (1) The vortex-induced aerodynamic loads are large and highly nonlinear, sometimes discontinuous in character; and (2) the vortex-induced loads have opposite effects on static and dynamic stability characteristics. Analytic approximations are presented which can predict these vortex-induced aerodynamic effects with the accuracy needed for most engineering design. S E S

N79-15085# California Inst of Tech Pasadena
OSCILLATORY AERODYNAMICS AND STABILITY DERIVATIVES FOR AIRFOIL SPOILER MOTIONS

R Bernier and G V Parkinson /in AGARD Dyn Stability Parameters Nov 1978 7 p refs. Prepared in cooperation with British Columbia Univ Vancouver

Avail NTIS HC A99/MF A01

An extension of a previously developed linearized incompressible potential flow theory is used in the lift, pitching moment and spoiler hinge moment for a thin airfoil section with an upper-surface spoiler oscillating about a mean erection angle. Integral transforms the transient lift and moment following spoiler erection are calculated. Results indicate that either the oscillatory or the transient loadings can be related to the conventional stability derivatives for spoiler displacement and rate. The oscillatory loadings produce frequency-dependent functions for the stability derivatives, while the transient loadings lead to a conventional constant displacement derivatives, but a time-dependent function for the rate derivative. S E S

N79-15086# National Aeronautics and Space Administration Ames Research Center Moffett Field Calif

THE ROLE OF TIME-HISTORY EFFECTS IN THE FORMULATION OF THE AERODYNAMICS OF AIRCRAFT DYNAMICS

Murray Tobak and Lewis B Schiff /in AGARD Dyn Stability Parameters Nov 1978 10 p refs

Avail NTIS HC A99/MF A01

The scope of any aerodynamic formulation proposing to embrace a range of possible maneuvers is shown to be determined principally by the extent to which the aerodynamic indicial response is allowed to depend on the past motion. Starting from the linearized formulation in which the indicial response is independent of the past motion, two successively more compre-

hensive statements about the dependence on the past motion are assigned to the indicial response (1) dependence only on the recent past and (2) dependence additionally on a characteristic feature of the distant past. The first enables the rational introduction of nonlinear effects and accommodates a description of the rate-dependent aerodynamic phenomena characteristic of airfoils in low-speed dynamic stall, the second permits a description of the double-valued aerodynamic behavior characteristic of certain kinds of aircraft stall. An aerodynamic formulation based on the second statement automatically embracing the first may be sufficiently comprehensive to include a large part of the aircraft's possible maneuvers. The results suggest a favorable conclusion regarding the role of dynamic stability experiments in flight dynamics studies. Author

N79-15087# Royal Aircraft Establishment Farnborough (England) Aerodynamics Dept

MATHEMATICAL MODELS OF AIRCRAFT DYNAMICS FOR EXTREME FLIGHT CONDITIONS (THEORY AND EXPERIMENT)

H H B M Thomas and Geraldine Edwards. In AGARD Dyn Stability Parameters Nov 1978 52 p refs

Avail NTIS HC A99/MF A01

The basic features of various formulations of the aerodynamic forces and moments acting on an aircraft are examined. Results from mathematical models of an aircraft indicate that motions such as spin entry pose new problems. These relate to the question of which contributions to the aerodynamic forces and moments may be linearized and which have to be included within a term which is a function of some of the state variables. The essential overall validation that tests using free-flight models can provide is discussed. A related wind tunnel test program which can provide validation is outlined. The sensitivity of the motion to changes is examined. S E S

N79-15089# Northrop Corp Hawthorne Calif Aircraft Group

AIRCRAFT STABILITY CHARACTERISTICS AT HIGH ANGLES OF ATTACK

Juri Kalviste. In AGARD Dyn Stability Parameters Nov 1978 18 p refs

Avail NTIS HC A99/MF A01

An analysis technique where six-degree-of-freedom equations are partitioned into rotational and translational equations of motion retaining all the cross coupling between the longitudinal and lateral directional modes of motion is reported. The aircraft stability is characterized in terms of aircraft rotational motion due to static aerodynamic coefficients. A new dynamic stability axes system is defined. Stability parameters are defined about the dynamic stability axes system. A new set of stability criteria is defined in terms of the new dynamic stability derivatives. The analysis takes into account nonlinear aerodynamics and nonzero moments at zero sideslip condition. The definition of the Lateral Control Departure Parameter (LCDP) is extended for nonlinear aerodynamics and defined in terms of angle of attack and sideslip. The new criteria was validated with complete six-degree-of-freedom perturbation equation stability analysis, nonlinear time history simulation, and flight test results. S E S

N79-15090# Office National d'Etudes et de Recherches Aérospatiales Paris (France)

NON-LINEAR FORMULATION OF THE AERODYNAMIC FORCES FOR FLIGHT DYNAMIC STUDIES

Michel Scherer. In AGARD Dyn Stability Parameters Nov 1978 24 p refs. In FRENCH ENGLISH summary

Avail NTIS HC A99/MF A01

The information on the nonlinear domain involved in flight at high angle of attack is studied. Adequate aerodynamic data for the application of nonlinear analysis methods are discussed. Examples of formulation proposed by various authors in flight dynamics studies are presented. S E S

N79-15091# Royal Aircraft Establishment Bedford (England) Structures Dept

NONLINEAR OSCILLATIONS AT HIGH INCIDENCE

G D Padfield. In AGARD Dyn Stability Parameters Nov 1978 16 p refs

Avail NTIS HC A99/MF A01

Approximations were developed for free aircraft motion when nonlinear effects are present and when the aircraft is flying close to a stability boundary. The analysis is based on the behavior of the isolated critical mode. The method of multiple scales is used to predict the transient oscillatory growth to a limit cycle condition. Results for the lateral motion of slender aircraft with nonlinear aerodynamic moments have revealed that limit cycles are possible above and below the critical incidence. Aircraft motions can be stable when the linear theory predicts instability and unstable when stability is predicted. Within the framework of the perturbation analysis it is shown how damping moments may be synthesized from response measurements. S E S

N79-15092# Royal Military Coll of Science Shrivenham (England) Dept of Mathematics and Ballistics

THE DYNAMIC STABILITY IN FLIGHT OF SPINNING BLUNT BODY PROJECTILES

P C Parks. In AGARD Dyn Stability Parameters Nov 1978 8 p ref

Avail NTIS HC A99/MF A01

Precessional motions of spinning blunt projectiles with highly non-linear pitching moment characteristics were analyzed. The precessional motion for a particular cylindrical projectile was investigated. A solution is proposed involving an optimum rounding of the leading edge of the projectile; this alters the pitching moment characteristics and also reduces drag. The precessional motion in pitch and yaw about the flight path of the projectile was examined. Proposals for improving their performance in flight by rounding the leading edge were made. S E S

N79-15093*# National Aeronautics and Space Administration Langley Research Center Hampton Va

RESULTS OF PILOTED SIMULATOR STUDIES OF FIGHTER AIRCRAFT AT HIGH ANGLES OF ATTACK

Joseph R Chambers, William R Gilbert, and Luat T Nguyen. In AGARD Dyn Stability Parameters Nov 1978 13 p refs

Avail NTIS HC A99/MF A01

The experience gained at the NASA Langley Research Center during the application of simulator techniques to high angle of attack flight conditions for several current fighters is discussed. The discussion includes (1) the simulator hardware, (2) requirements for static and dynamic aerodynamic data inputs, (3) evaluation procedures, (4) correlation with flight, and (5) the effects of dynamic stability parameters. Results obtained with the simulator technique have correlated well with flight test experience, resulting in early identification of potential problems, identification of critical flight conditions, and solutions to various deficiencies in stability and control characteristics. Dynamic stability parameters results indicate that certain parameters can have a large influence on the flying qualities and tactical effectiveness of fighters at high angles of attack. S E S

N79-15094# Sandia Labs Albuquerque N Mex

SENSITIVITY OF AIRCRAFT MOTION TO AERODYNAMIC CROSS-COUPLING AT HIGH ANGLES OF ATTACK

W H Curry and K J Orlik-Rueckemann. In AGARD Dyn Stability Parameters Nov 1978 18 p refs. Prepared in cooperation with National Aeronautical Establishment Ottawa. Sponsored in part by DOE.

Avail NTIS HC A99/MF A01

The equation of motion was examined using a six-degree-of-freedom simulation on a hybrid computer. Both straight and turning flight conditions were included, and to simplify the problem the equations were formulated for the constant-thrust stick-fixed condition. The aerodynamic cross-coupling derivatives were considered both as constants and as locally linearized functions of angle of attack. The effects of varying certain derivatives from an assumed nominal set on the response of the aircraft to

an initial perturbation are presented graphically Results indicate that the dynamic cross-coupling moment derivatives due to pitching have a marked effect while those due to yawing are relatively unimportant S E S

N79-15095# ARO Inc Arnold Air Force Station Tenn
AIRCRAFT MOTION SENSITIVITY TO VARIATIONS IN DYNAMIC STABILITY PARAMETERS

R W Butler and T F Langham /in AGARD Dyn Stability Parameters Nov 1978 11 p refs Sponsored by the Air Force

Avail NTIS HC A99/MF A01

A 6-DOF nonlinear and 5-DOF linearized dynamic sensitivity study was conducted on a fighter/bomber and attack type aircraft The dynamic derivatives investigated in the study were $C_{\dot{\alpha}}$, $C_{\dot{\beta}}$, $C_{\dot{\gamma}}$, $C_{\dot{\delta}}$, $C_{\dot{\epsilon}}$, $C_{\dot{\zeta}}$, $C_{\dot{\eta}}$, $C_{\dot{\theta}}$, $C_{\dot{\phi}}$, $C_{\dot{\psi}}$, $C_{\dot{\chi}}$, $C_{\dot{\psi}}$, $C_{\dot{\chi}}$, $C_{\dot{\psi}}$, $C_{\dot{\chi}}$ The cross-coupling derivatives $C_{\dot{\alpha}\beta}$, $C_{\dot{\alpha}\gamma}$, $C_{\dot{\alpha}\delta}$, $C_{\dot{\alpha}\epsilon}$, $C_{\dot{\alpha}\zeta}$, $C_{\dot{\alpha}\eta}$, $C_{\dot{\alpha}\theta}$, $C_{\dot{\alpha}\phi}$, $C_{\dot{\alpha}\psi}$, $C_{\dot{\alpha}\chi}$, $C_{\dot{\beta}\gamma}$, $C_{\dot{\beta}\delta}$, $C_{\dot{\beta}\epsilon}$, $C_{\dot{\beta}\zeta}$, $C_{\dot{\beta}\eta}$, $C_{\dot{\beta}\theta}$, $C_{\dot{\beta}\phi}$, $C_{\dot{\beta}\psi}$, $C_{\dot{\beta}\chi}$, $C_{\dot{\gamma}\delta}$, $C_{\dot{\gamma}\epsilon}$, $C_{\dot{\gamma}\zeta}$, $C_{\dot{\gamma}\eta}$, $C_{\dot{\gamma}\theta}$, $C_{\dot{\gamma}\phi}$, $C_{\dot{\gamma}\psi}$, $C_{\dot{\gamma}\chi}$, $C_{\dot{\delta}\epsilon}$, $C_{\dot{\delta}\zeta}$, $C_{\dot{\delta}\eta}$, $C_{\dot{\delta}\theta}$, $C_{\dot{\delta}\phi}$, $C_{\dot{\delta}\psi}$, $C_{\dot{\delta}\chi}$, $C_{\dot{\epsilon}\zeta}$, $C_{\dot{\epsilon}\eta}$, $C_{\dot{\epsilon}\theta}$, $C_{\dot{\epsilon}\phi}$, $C_{\dot{\epsilon}\psi}$, $C_{\dot{\epsilon}\chi}$, $C_{\dot{\zeta}\eta}$, $C_{\dot{\zeta}\theta}$, $C_{\dot{\zeta}\phi}$, $C_{\dot{\zeta}\psi}$, $C_{\dot{\zeta}\chi}$, $C_{\dot{\eta}\theta}$, $C_{\dot{\eta}\phi}$, $C_{\dot{\eta}\psi}$, $C_{\dot{\eta}\chi}$, $C_{\dot{\theta}\phi}$, $C_{\dot{\theta}\psi}$, $C_{\dot{\theta}\chi}$, $C_{\dot{\phi}\psi}$, $C_{\dot{\phi}\chi}$, $C_{\dot{\psi}\chi}$ are shown to have significant effects on the aircraft motion in 1 g flight and 2 g turning flight while the derivatives $C_{\dot{\alpha}\delta}$, $C_{\dot{\alpha}\epsilon}$, $C_{\dot{\alpha}\zeta}$, $C_{\dot{\alpha}\eta}$, $C_{\dot{\alpha}\theta}$, $C_{\dot{\alpha}\phi}$, $C_{\dot{\alpha}\psi}$, $C_{\dot{\alpha}\chi}$, $C_{\dot{\beta}\delta}$, $C_{\dot{\beta}\epsilon}$, $C_{\dot{\beta}\zeta}$, $C_{\dot{\beta}\eta}$, $C_{\dot{\beta}\theta}$, $C_{\dot{\beta}\phi}$, $C_{\dot{\beta}\psi}$, $C_{\dot{\beta}\chi}$, $C_{\dot{\gamma}\delta}$, $C_{\dot{\gamma}\epsilon}$, $C_{\dot{\gamma}\zeta}$, $C_{\dot{\gamma}\eta}$, $C_{\dot{\gamma}\theta}$, $C_{\dot{\gamma}\phi}$, $C_{\dot{\gamma}\psi}$, $C_{\dot{\gamma}\chi}$, $C_{\dot{\delta}\epsilon}$, $C_{\dot{\delta}\zeta}$, $C_{\dot{\delta}\eta}$, $C_{\dot{\delta}\theta}$, $C_{\dot{\delta}\phi}$, $C_{\dot{\delta}\psi}$, $C_{\dot{\delta}\chi}$, $C_{\dot{\epsilon}\zeta}$, $C_{\dot{\epsilon}\eta}$, $C_{\dot{\epsilon}\theta}$, $C_{\dot{\epsilon}\phi}$, $C_{\dot{\epsilon}\psi}$, $C_{\dot{\epsilon}\chi}$, $C_{\dot{\zeta}\eta}$, $C_{\dot{\zeta}\theta}$, $C_{\dot{\zeta}\phi}$, $C_{\dot{\zeta}\psi}$, $C_{\dot{\zeta}\chi}$, $C_{\dot{\eta}\theta}$, $C_{\dot{\eta}\phi}$, $C_{\dot{\eta}\psi}$, $C_{\dot{\eta}\chi}$, $C_{\dot{\theta}\phi}$, $C_{\dot{\theta}\psi}$, $C_{\dot{\theta}\chi}$, $C_{\dot{\phi}\psi}$, $C_{\dot{\phi}\chi}$, $C_{\dot{\psi}\chi}$ show little effect in the same regime The acceleration derivatives $C_{\dot{\alpha}\delta}$, $C_{\dot{\alpha}\epsilon}$, $C_{\dot{\alpha}\zeta}$, $C_{\dot{\alpha}\eta}$, $C_{\dot{\alpha}\theta}$, $C_{\dot{\alpha}\phi}$, $C_{\dot{\alpha}\psi}$, $C_{\dot{\alpha}\chi}$, $C_{\dot{\beta}\delta}$, $C_{\dot{\beta}\epsilon}$, $C_{\dot{\beta}\zeta}$, $C_{\dot{\beta}\eta}$, $C_{\dot{\beta}\theta}$, $C_{\dot{\beta}\phi}$, $C_{\dot{\beta}\psi}$, $C_{\dot{\beta}\chi}$, $C_{\dot{\gamma}\delta}$, $C_{\dot{\gamma}\epsilon}$, $C_{\dot{\gamma}\zeta}$, $C_{\dot{\gamma}\eta}$, $C_{\dot{\gamma}\theta}$, $C_{\dot{\gamma}\phi}$, $C_{\dot{\gamma}\psi}$, $C_{\dot{\gamma}\chi}$, $C_{\dot{\delta}\epsilon}$, $C_{\dot{\delta}\zeta}$, $C_{\dot{\delta}\eta}$, $C_{\dot{\delta}\theta}$, $C_{\dot{\delta}\phi}$, $C_{\dot{\delta}\psi}$, $C_{\dot{\delta}\chi}$, $C_{\dot{\epsilon}\zeta}$, $C_{\dot{\epsilon}\eta}$, $C_{\dot{\epsilon}\theta}$, $C_{\dot{\epsilon}\phi}$, $C_{\dot{\epsilon}\psi}$, $C_{\dot{\epsilon}\chi}$, $C_{\dot{\zeta}\eta}$, $C_{\dot{\zeta}\theta}$, $C_{\dot{\zeta}\phi}$, $C_{\dot{\zeta}\psi}$, $C_{\dot{\zeta}\chi}$, $C_{\dot{\eta}\theta}$, $C_{\dot{\eta}\phi}$, $C_{\dot{\eta}\psi}$, $C_{\dot{\eta}\chi}$, $C_{\dot{\theta}\phi}$, $C_{\dot{\theta}\psi}$, $C_{\dot{\theta}\chi}$, $C_{\dot{\phi}\psi}$, $C_{\dot{\phi}\chi}$, $C_{\dot{\psi}\chi}$ each have a significant influence on the aircraft motion in 1 g flight The interactive nature of the dynamic derivatives in the aircraft equations of motion is documented G Y

N79-15096# Systems Technology, Inc., Hawthorne Calif
IDENTIFICATION OF KEY MANEUVER-LIMITING FACTORS IN HIGH-ANGLE-OF-ATTACK FLIGHT

Donald E Johnston /in AGARD Dyn Stability Parameters Nov 1978 12 p refs

(Contracts F33615-73-C-3101, F33615-76-C-3072)

Avail NTIS HC A99/MF A01

Results of a current analytic and simulation investigation of maneuver-limiting (e.g., loss of control) factors in fighter aircraft at high angle-of-attack are reported Two goals of the program are to identify the key parameters which result in high-angle-of-attack maneuver-limiting phenomena such as wing rock nose slice and rolling divergence and to demonstrate the influence of these key parameters in controlling the nature of the maneuver-limiting phenomena This analysis and simulation have centered on unsymmetric flight Author

N79-15097# Institut fuer Flugmechanik Brunswick (West Germany)

GUST-VEHICLE PARAMETER IDENTIFICATION BY DYNAMIC SIMULATION IN WIND-TUNNELS

B Krag /in AGARD Dyn Stability Parameters Nov 1978 6 p

Avail NTIS HC A99/MF A01

A description of the DFVLR (Deutsche Forschungs- und Versuchsanstalt fuer LUFT- und Raumfahrt) installation for dynamic simulation in wind tunnels is given The application of this research installation in a research program and its capability and limitation are described G Y

N79-15098# Quanta Systems Corp., Rockville Md
LIGHTING AND MARKING OF EXIT TAXIWAYS

Charles A Douglas Aug 1978 38 p refs Prepared for

Naval Air Engineering Center Lakehurst N J

(Contracts N68335-78-C-2022 DOT-FA77WAI-786)

(AD-A060259 FAA-RD-78-94) Avail NTIS

HC A03/MF A01 CSCL 01/5

The feasibility of emphasizing the visibility of the throat of an exit taxiway by means of special lights was investigated in the literature The use of green lights installed in the runway surface on the extended taxiway centerline marking is in common use for lighting both high speed and low speed exits was not adopted in the United States because of concern over the possibility of mistaking a low speed exit for a high speed exit Tests to determine if this concern is valid are recommended A system of pulsating blue lights at the entrance to the throat shows promise Tests of this system are recommended Modifying the type L-829 signs located at exits from the runway to increase their conspicuity improved shielding of taxiway edge lights use of asymmetric instead of symmetric lenses on straight stretches

dimming of taxiway edge lights would improve the guidance and reduce the sea-of-blue effect Tests of these modifications are recommended The use of high-efficiency retroreflective paint to mark the turn-offs to the exit taxiway will improve nighttime guide and is recommended A R H

N79-15099# Advanced Technology, Inc McLean, Va
TOWER AIRPORT STATISTICS HANDBOOK, CALENDAR YEAR 1977 Final Report

Ronald Hobbs and Winfred Wu 15 Jul 1978 593 p

(Contract DOT-FA78WA-4151)

(AD-A060217, FAA-AVP-78-10) Avail NTIS

HC A25/MF A01 CSCL 01/5

Full year 1977 daily aircraft operations were obtained from 426 towered airports (424 operated by the Federal Aviation Administration (FAA)) A package of computer programs was used to perform statistical analyses on six user types of daily operations as reported on FAA Form 7230-1, Airport Traffic Record The output of the computer programs displayed specific statistics in tabular and graphical format The tabular statistics included means standard deviations and peak occurrences computed for individual airports as well as various multiple airport groupings Frequency distribution histograms and time curves are presented in a graphical format for the entire nationwide set of FAA towered airports B B

N79-15100# Air Force Systems Command Tyndall AFB Fla
ADTC

DYNAMIC RESPONSE OF AIRCRAFT TO UNLOADED AND LOADED PAVEMENT PROFILES Final Report

William H Highter and Mark R Snyder Aug 1978 62 p refs

(Contract DOT-FA73WAI-361)

(AD-A059787 CEEDO-TR-77-42 FAA-RD-77-160) Avail

NTIS HC A04/MF A01 CSCL 01/5

The simulated dynamic response of an F-4C aircraft traversing either an unloaded (undeflected) or loaded (deflected) pavement profile is examined The Air Force computer code TAXI was adapted for use on the Clarkson College IBM 360 Model 65 computer from the CDC 6600 computer used by the Air Force Civil Engineering Center The TAXI code calculates the vertical accelerations at three points on an aircraft as the aircraft traverses a pavement profile It appears that there is no significant difference in the response of TAXI to unloaded and loaded pavement profiles at speeds up to 133.3 feet per second At higher speeds some rejections of the mean do occur but in light of the continuous acceptance of the test of the distribution and the predominant acceptance of the test of the mean, these are felt to be insignificant It appears that the present practice of using unloaded pavement profiles for aircraft dynamic response simulation is acceptable and loaded pavement profiles need not be obtained for this purpose J M S

N79-15101*# Research Triangle Inst., Research Triangle Park N C
Systems and Measurements Div

SYSTEMS DEVELOPMENT OF A STALL/SPIN RESEARCH FACILITY USING REMOTELY CONTROLLED/AUGMENTED AIRCRAFT MODELS VOLUME 1 SYSTEMS OVERVIEW

R J Montoya, A R Jai and C D Parker Jan 1979 87 p refs

(Contract NAS1-14638 RTI Proj 43U-1362)

(NASA-CR-145351 RTI/1362-00-01F) Avail NTIS

HC A05/MF A01 CSCL 14B

A ground based general purpose, real time digital control system simulator (CSS) is specified developed and integrated with the existing instrumentation van of the testing facility This CSS is built around a PDP-11/55, and its operational software was developed to meet the dual goal of providing the immediate capability to represent the F-18 drop model control laws and the flexibility for expansion to represent more complex control laws typical of control configured vehicles Overviews of the two CSSs developed are reviewed as well as the overall system after their integration with the existing facility Also the latest version of the F-18 drop model control laws (REV D) is described

and the changes needed for its incorporation in the digital and analog CSS s are discussed B B

N79-15102# Army Research Inst for the Behavioral and Social Sciences, Alexandria Va

EVALUATION OF A FLIGHT SIMULATOR (DEVICE 2B24) FOR MAINTAINING INSTRUMENT PROFICIENCY AMONG INSTRUMENT-RATED ARMY PILOTS

Donald O Weitzman Michael L Fineberg, and George L Compton
Jul 1978 37 p refs
(AD-A060557 ARI-TP-298) Avail NTIS HC A03/MF A01 CSCL 14/2

The research aims to evaluate the operational suitability of Device 2B24 which simulates the UH-1H helicopter for facilitating UH-1H instrument proficiency training and proficiency assessment among instrument rated pilots The present data indicate that substantial amounts of UH-1H time can be substituted by Device 2B24 time in instrument proficiency training and proficiency assessment With simulators, the Army has the opportunity to establish an instrument training program that can maintain and assess instrument proficiency year round and at a reasonable cost A reasonable conclusion from this study is that a realistic instrument training program that includes simulator training would reduce accidents and enhance combat readiness among instrument rated pilots Author (GRA)

N79-15103# Singer Co Sunnyvale Calif Link Div
ADVANCED DIGITAL SIMULATOR SYSTEM (ADSS) Final Report

Jul 1978 169 p ref
(Contract DAAK70-77-C-0175)
(AD-A059536) Avail NTIS HC A08/MF A01 CSCL 15/4

A digital simulation system designed for the laboratory evaluation of various types of sensors either singly or as weapon systems permits simulation not only of the intrinsic qualities (bandwidth resolution, range, frequency, etc) but also of the operating environment such as helicopter, fixed wing, RVP The system comprises an executive computer to control the overall simulation tasks a sensor simulator that is easily programmable to model any sensor under evaluation possibly a microwave simulator to model any radar device a readily modified CRT display, a data base that includes terrain, culture moving targets and ordnance, and a scoring (evaluation) console A R H

N79-15187# National Aeronautics and Space Administration
Ames Research Center Moffett Field Calif

FLASH-FIRE PROPENSITY AND HEAT-RELEASE RATE STUDIES OF IMPROVED FIRE RESISTANT MATERIALS

Larry L Fewell Dec 1978 46 p
(NASA-TM-78550 A-7548) Avail NTIS HC A03/MF A01 CSCL 11E

Twenty-six improved fire resistant materials were tested for flash-fire propensity and heat release rate properties The tests were conducted to obtain a descriptive index based on the production of ignitable gases during the thermal degradation process and on the response of the materials under a specific heat load Author

N79-15199# National Aeronautics and Space Administration
Lewis Research Center, Cleveland Ohio

HIGH FREEZING POINT FUELS USED FOR AVIATION TURBINE ENGINES

Robert Friedman 1979 14 p refs To be presented at the 24th Ann Intern Gas Turbine Conf San Diego Calif 11-15 Mar 1979 sponsored by ASME
(NASA-TM-79015 E-9804) Avail NTIS HC A02/MF A01 CSCL 21D

Broadened-specification aviation fuels could be produced from a greater fraction of crude source material with improvements in fuel supply and price These fuels particularly those with increased final boiling temperatures would have higher freezing temperatures than current aviation turbine fuels For the small but significant fraction of commercial flights where low fuel temperatures make higher freezing-point fuel use unacceptable

adaptations to the fuel or fuel system may be made to accomodate this fuel Several techniques are discussed Fuel heating is the most promising concept One simple design uses existing heat rejection from the fuel-lubricating oil cooler, another uses an engine-driven generator for electrical heating A R H

N79-15203# Dayton Univ Research Inst Ohio
BEHAVIOR OF NONMETALLIC MATERIALS IN SHALE OIL DERIVED JET FUELS AND IN HIGH AROMATIC AND HIGH SULFUR PETROLEUM FUELS Final Report, Jan 1975 - Aug 1977

William E Berner and Leonard C Angello Wright-Patterson AFB Ohio AFML Jul 1978 84 p refs
(Contract F33615-76-C-5034 AF Proj 2421)
(AD-A060322 AFML-TR-78-100) Avail NTIS HC A05/MF A01 CSCL 21/4

Aircraft materials that are normally in contact with or exposed to fuels were evaluated in order to determine their compatibility with fuels previously considered unacceptable, such as those derived from shale oil or those having high levels of aromatics sulfur and mercaptan sulfur Adhesives, coatings sealants O ring seals, and clamps were studied in ten fuel formulations A R H

N79-15232# Range Commanders Council White Sands Missile Range N Mex

FLIGHT TERMINATION RECEIVER CATALOG

Sep 1978 145 p
(AD-A058656 RSG-306-78) Avail NTIS HC A07/MF A01 CSCL 17/2

The catalog provides a ready reference to UHF flight termination receivers used at missile ranges and test facilities Approval for use of a particular receiver on one range for a given missile does not constitute automatic approval for use of the same receiver on other missile/space vehicles on the same range, or on the same missile space/vehicle on other ranges G G

N79-15447# Committee on Government Operations (U S House)

AIRCRAFT/AIRPORT NOISE CONTROL

Washington GPO 1977 834 p refs Hearings before a subcomm of the Comm on Government Operations 95th Congr, 1st Sess, 4-5 Apr 20 May 21 Jun 7-9 Sep and 26 Oct 1977
(GPO-93-187) Avail Comm on Government Operations

The effectiveness of the Federal program which was established to control and lessen noise pollution is reviewed with emphasis on aircraft/airport noise control Topics covered include noise emission standards for consumer products railroads and motor carriers engaged in interstate commerce aircraft/airport noise reduction regulations and coordination of noise research and control programs J M S

N79-15486# Logistics Management Inst Washington D C
THE ECONOMIC IMPACT OF REVISED GASEOUS EMISSION REGULATIONS FOR COMMERCIAL AIRCRAFT ENGINES

C F Day and H E Bertrand Jan 1978 128 p
(Contract EPA-68-01-4647)
(PB-286772/9) Avail NTIS HC A07/MF A01 CSCL 13B

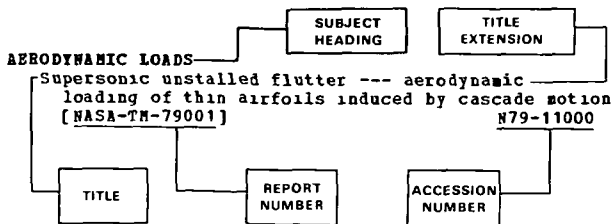
The EPA has proposed the revision of the gaseous emission regulations first promulgated in 1973 (40 CFR Part 87) for several classes of aircraft engines A draft notice of proposed rule making was prepared and circulated informally outside EPA in the late summer of 1977 The results of an economic impact analysis of the proposed standards are presented as they apply to commercial aircraft engines GRA

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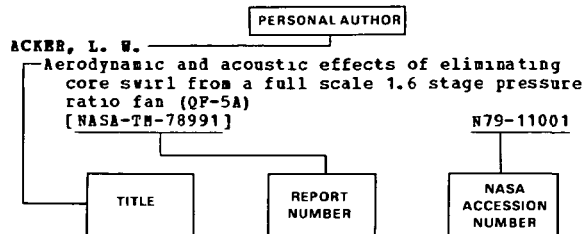
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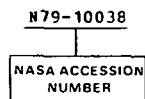
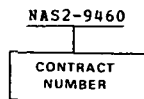
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